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THE FUNCTION OF THE ENGINEER IN THE CONSERVATION OF THE NATURAL RESOURCES OF THE COUNTRY

THE prosperity of a country depends primarily upon its natural resources. The raw material which the farmer and the manufacturer use and the products of which furnish business for the merchant, come from or depend upon timber, fuel, minerals, soil, water. These are the natural resources of any country, and as they exist in large or small quantities, as they are easy of access, as their quality is good or bad, must depend the agricultural and industrial prosperity and success of the nation. Some countries have large supplies of one or more of these natural products and a few are blessed with them all. This country is especially fortunate in that it originally had within its bounds not only all of these natural resources, but large quantities of each of them, and that they were rich in quality and easy of access. When the country was first settled by Europeans, the new inhabitants gave little thought to the question of natural resources except in so far as these directly concerned their daily life. They established themselves where the soil was rich because they wished to pursue agriculture as a vocation, but they made no study of soils further than this. Forests were regarded as an encumbrance to be cleared away as soon as possible, for they interfered with agriculture, which was the chief business, and they were the lurking places of wild beasts and wilder men. They were useful only for the purpose of furnishing lumber and

fuel. A very small amount of forest on each farm was sufficient for these purposes and so the settler did not hesitate to cut down as much as he possibly could. The other natural resources he knew little or nothing about. It was many years before coal came into use, and then only in those sections where it could be dug from the ground near at hand. Precious metals were unknown. The little iron that was used was brought from abroad. The waterways were used wherever possible and in many sections of the country they were the only avenues of travel and the supply of water was sufficient for the purpose of navigation. Under conditions such as these it was only natural for the inhabitants to suppose that the resources of the country were inexhaustible. They had all they could use and more, and if they had thought of the question of exhaustion, it would have seemed to them that all they had to do was to move to another section, north, south or west, and start over again. While they depended for their livelihood upon one of the natural resources, the soil, they were practically independent of most of the others. And hence they regarded them as of little moment. As the country developed and civilization increased their dependence upon the natural resources increased also, but at first in a scarcely perceptible way. This dependence has grown up to the present time, but it is still difficult to make people see the force of this dependence. Most of the products which come from the natural resources of the country are used at a great distance from the raw material, and hence it is difficult for people to realize the connection between the two and their dependence upon the latter. The natural resources have been so freely drawn upon and often so ruthlessly used that already along some lines they are beginning to disappear to an alarming degree. Investigation has shown that they are in great danger of exhaustion. This is a grave state of affairs and proper steps should be taken so far as possible to prevent it by preserving the natural resources that remain and by carefully and judiciously using them in the future. Unless we can prevent the absolute destruction of the natural resources the ruin of the nation is assured. We should aim to transmit to the generations which are to follow us a country which is better than the one we received from our ancestors and not one which is being rapidly depleted and impoverished. That this can be done has been shown by the work of scientific men during the past few years. Of course some of the natural resources can not be replaced, but their rapid depletion can be stopped and they can be preserved for our use for many centuries. The soil should never be allowed to grow poor. It should grow richer as it is cultivated longer. The forests can be retained through planting at the same time that timber is being cut for use. Fuel and iron can not be replaced, but they can be carefully and economically used. The use of water, either for navigation or power, does not destroy the water and hence does not endanger the waterways system.

With the growth of civilization the wants of men multiply and hence greater demands are made upon nature, for the supply with which these wants are satisfied must come primarily from nature. This will cause a greater drain in the future than in the past. The use of the natural resources has made us a great nation, and if we are to maintain our position among other nations we must be able to use these natural resources in the future, and even to draw upon them to a greater degree. This makes it absolutely essential that the wasteful methods now in use should cease and that a careful and systematic study of the use of the materials we now have be intelli-

gently made. Our land is nearly all taken up. There is remaining in the possession of the government a comparatively small amount excepting that which is useless for cultivation. Nearly all the forests have disappeared; in some sections entirely so, and very little effort has been made to replace them. Our coal and iron are rapidly disappearing and will in time entirely disappear. Our waterways are injured and many of them are entirely useless for navigation or for power. The question of the conservation of our natural resources is then a serious one and deserves careful and mature deliberation. Even with the natural resources not in danger of exhaustion it would seem wise to use them to the best advantages.

On May 13, 14 and 15 there was held at the White House in Washington a conference on the conservation of the natural resources of the country. This conference gathered at the invitation of the President of the United States and was composed of the governors of the states with three delegates from each state appointed by the governor; of the members of the cabinet, the judges of the supreme court, some of the members of congress, and representatives from all the great engineering societies. As president of this society I received an invitation and attended the conference. This meeting was one of the most notable ever held in the country. The President of the United States opened each session and presided at the first and last. At the opening session he delivered a strong address upon the question of conservation which is one that has received his earnest attention for many years. The governors of forty-four states were present. Many members of the cabinet, of the supreme court and of both houses of congress accepted the invitation and attended one or more of the sessions.

Addresses were made upon the subjects of forestry, fuel, mineral products, soil wastage, irrigation and the waterways. Papers were read by Mr. Andrew Carnegie and Mr. James J. Hill, who have taken a great interest in the questions under consideration. Many of the governors and quite a number of the other delegates took part in the discussion. Every one present seemed to be impressed with the importance of the gathering. To many of the governors and their associates the subject seemed to be entirely new. It had never been directly presented to them and they had not, of course, understood its importance, but there was not a dissenting voice as to the necessity of conserving our natural resources and making them serve the nation as long as possible. A number of the governors stated that upon their return home they would immediately appoint forestry and other commissions which would study these questions within the borders of their states, and that when these commissions made their reports they would do all in their power to carry out the recommendations.

The representatives of the scientific societies probably appreciated the condition of affairs and the momentous possibilities of the questions discussed better than any one else with, perhaps, the exception of the president. Some of them read papers and a number took part in the discussions. At the close of the session a statement of the present condition of affairs and a recommendation as to the proper steps to be taken to conserve the natural resources of the country were adopted as the sense of the convention.

The engineer adapts the forces of nature to the use of men and this adaptation should be done both economically and efficiently. It is not enough to show that a certain force can be made to work when a machine transforms raw into finished product. The work must be done efficiently—

that is to say, the greatest amount of good must come from a given expenditure of energy. This makes the machine efficient and shows that it is doing all that it is possible for it to do, and when this is the case it is generally considered that the engineer has successfully performed his duty. If it is a question of using the force or material in some other way, through some other kind of machine; then the engineer may also be concerned and it may be necessary for him to change his methods of work to conform to a new demand—that is, of economy. In some cases the application of the force or the use of material is not economical, for reasons which are beyond the power of the engineer to control, for they may be economic in their character. In the future, waste of raw material should be abhorrent to the engineer and his aim should be to conserve the materials which nature has provided for his use. The agriculturist and the forester, as well as the engineer, are concerned in the conservation of the natural resources, but in a broad sense all may be considered as belonging to the same class. They all develop the natural resources of the country and prepare them for the use of men. I shall speak of these resources separately and try to show in what way the engineer, the forester and the agriculturist may work for their conservation.

FORESTS

I have already stated that in the early days of our history it was the one aim of the settler to destroy the forests because they were in his way. He was an agriculturist and needed to have his land cleared of trees and other obstructions in order that he might harvest the greatest crop. As the country grew the demand for lumber increased and then it became necessary to save the trees in the forest and turn them into lumber, but the supply still seemed inexhaustible and only the finest and best of the trees were used. The destructive use of the forests thus begun has continued ever since, though perhaps not in so great a degree. It takes from thirty to seventy-five years to grow a tree, but the lumbermen only cut those which have grown the straightest and cleanest and only use the best parts of the tree that is cut. The branches and the upper part of the tree are left to decay in the forest. They are not only wasted, but they are scattered over the ground in such a way as to prevent future growth, for the soil is covered with a mat of material through which it is hard for any living thing to penetrate. It is necessary to burn this over in order that a new growth may rapidly start. But the burning over of the forest effectually kills the young trees which were growing among the old ones and thus entails a further loss upon the forest and its owner.

The demand for lumber has increased enormously during the past few years. In 1880 the consumption per capita in the United States was 360 feet, while in 1906 it was 440 feet. The total amount of lumber cut in 1906 was over 40,000,000,000 feet, and this yearly amount will largely increase in the future, both through the increase in population and through the increase per capita, unless some steps are taken to prevent it. No accurate census of the amount of timber in the country has been made, but it is estimated that we have now of standing timber about fourteen hundred billion feet. We are using forty billion feet per year. Upon this basis the present lumber supply will last thirty-five years, but this does not take account of the increase in the amount used per year nor does it take into account the amount of timber which will grow during the next thirty-five years. If nothing is done to increase our forest area we may suppose that these two will balance each other, although it is probable that the lumber cut

will increase faster than the growth. But even the more conservative calculation shows that our forests can not last more than thirty-five years on the present basis of cutting. Long before that time the cost of lumber will largely increase and at the end of that period there will be no timber fit to cut. When we consider the extent to which wood is used at the present time, how much it means to all men, this is a most serious question.

The government has tried to check this depletion of our forests by establishing forest reserves in different parts of the country. It is estimated that at present there are in forests about seven hundred million acres, of which twenty per cent. are in national and state hands. This does not mean that all of this land is fully covered with forests, for large sections of it may be totally barren, but surrounded by forests in such a way that it is necessary to call the whole forest land, until a very accurate survey has been made. The National Bureau of Forestry of the United States Department of Agriculture and a number of state departments of forestry have done a great deal towards arousing public interest in the subject and establishing scientific methods of cultivation. Many of the state universities have established departments of forestry which are training foresters to take charge of the development of the forest interests of state and nation.

It is evident that in the future lumber must be considered as a crop to be planted and tended and harvested with the same care that other crops receive. It differs from them only in the methods of cultivation and the length of time necessary for its development. Under this scientific treatment trees will be planted on waste areas or other sections where ordinary crops are not profitable; they will be thinned out until only those which are likely to attain a mature growth are left, and they will be guarded against the destructive effect of forest fires. When a certain proportion of the crop is ready for harvesting the lumbermen will go in, cut the proper trees, carry away or burn the tops and branches, and then the forester will plant new trees in place of those felled. In a few years another crop will be ready and the same treatment will be repeated. The older forests will be treated in a similar way except that the first stage of planting will not be necessary. In this way the forests will yield a regular crop of lumber once in so often. Under this treatment the forests become profitable to a very much greater degree than under the old method of cutting off all trees large enough for lumber at one time and practically destroying all the young growth.

In some European countries where this method of forestry is in use the entire public expenses of many townships are met by the sale of timber from the public forest lands. Our government reserves now yield but a very small income, but in time, as they are brought under the proper cultivation, they will yield large results. As soon as forest planting is taken up on a large scale by national and state governments and by individuals, the lumber question of the future will be settled. This process, however, is a slow one and we must expect that before that time comes the present forest reserves will be largely exhausted. The danger, however, has been seen and the necessary methods for its correction have been developed. This has been the work of the scientific forester, but the labor can only be done by those agencies which can supply the necessary funds.

The engineer is greatly interested in this question because he needs timber for many of his operations. He also has a hand in the conservation of our forest areas because of the use which he makes of steel and concrete in structural work. The amount of

cement manufactured and used in the United States has increased each year until now it has reached vast proportions. Its use will be greatly increased in the future, especially in structural work, as we learn more and more about the strength of concrete reinforced with steel. The United States government, engineering concerns and technical colleges are making an extensive study of this great engineering question and the results of their researches are put into practise as soon as they are published. Every engineer believes that the opportunity for this kind of investigation is very great and that it should be encouraged by both national and state governments.

FUEL

Manufacturing industries depend upon fuel, and cheap fuel is a vital element of our supremacy in the world's markets. The amount used at the present time in the United States is very large. In 1906 the coal mined amounted to four hundred million tons of a value of five hundred and ten million dollars. The petroleum was valued at ninety million dollars; natural gas at fifty million dollars; coke at one hundred and ten million dollars and artificial gas at thirty million dollars. The total value of all fuels, including by-products, was almost one billion dollars.

Coal is found in almost every section of the United States, twenty-nine out of forty-six states having coal beds. Natural gas and petroleum are also found in many of the states. No matter how large the supply of these fuels may originally have been, a yearly drain, such as just mentioned, will inevitably in a few years sadly deplete it, and the amount used is increasing every year and at a very rapid rate. But this is not all; the figures just given are those for the fuel taken from the ground and used, but the amount wasted doubles or trebles this total. Although this latter has not been put to any use, it has been destroyed so far as its future usefulness is concerned.

Natural gas is one of the most perfect fuels in existence. It is found under such pressure that it can be carried long distances and delivered in the factory ready for use. The turning of a cock regulates the supply and there is no dirt or loss. Many wells which yield small amounts are allowed to waste their supply in the air and it has frequently happened that the product of large wells is more or less wasted because proper piping is not at hand or proper precautions have not been taken. In many oil wells there is more or less gas and little if any effort is made to secure this supply. One geologist estimates that at least a billion cubic feet of gas per day are allowed to go to waste in the United States. Only one state, Indiana, has passed stringent laws against this waste. This state found that her supply of natural gas was rapidly being exhausted and that factories formerly dependent upon it were obliged to change to some other form of fuel. After a large part of the supply had been exhausted, laws were passed forbidding operators to open gas or oil wells until precautions had been taken to save all the gas.

The waste in coal mines is very great. Nearly every coal vein has streaks of sulphurous or bony coal mixed with the first-class material. This contains a large amount of carbon, but is not as valuable as some parts of the seam; it is, therefore, left in piles inside the mine or dumped upon the culm bank on the outside. The amount of this low-grade coal varies from ten to fifty per cent. in every mine, and under the present system of mining and of coal using this is an absolute loss. As the roofs of coal mines will not support themselves and as timber is expensive it is the custom to leave great pillars of coal in the mine as supports. As a rule, these pillars are not

taken out and so become absolute waste. In most coal mines there are several layers of the coal separated by shale formation. Some of these are narrow and can not be mined to advantage; others are so broken up and dislocated by the mining of adjacent seams that it is impossible to take them out. All of these causes and perhaps some others make up a loss of from forty to seventy per cent. of the coal in the average coal mine of the country. As we obtain only thirty to sixty per cent. of the coal, it is evident that we are exhausting our coal fields twice as fast as the actual amount of fuel used would indicate.

This immense drain upon the coal supply must very soon have an effect. It has been estimated that our anthracite coal can not last more than seventy-five years. The bituminous coal will last much longer, but it will become exhausted in those places where it is now used to the greatest extent. The most important coal vein in the United States is in the Pittsburg belt and is being more rapidly mined than any other. Each acre of land has supplied about eight thousand tons of coal, and at this rate the state geologist of West Virginia estimates that at the beginning of the next century there will be no coal within one hundred miles of Pittsburg. No one can fail to perceive that this will be a terrible blow to the manufacturing industries of that great industrial center. In many sections of the country where neither anthracite nor bituminous coal is found large deposits of lignite exist. This lignite can be used for heating purposes in houses, but is worthless for manufacturing purposes because the amount of ash is so great that it will not produce steam. In sections of country where this is the only fuel supply it is necessary to bring coal from long distances, which makes it very expensive and puts a great tax upon manufacturing industries.

Our coal measures cover such an extensive area and the supply has seemed so great that the conservation of our fuels has received very little attention until within the past few years. In 1903 the Technologic Branch of the United States Geological Survey was established in St. Louis in connection with the exposition, and since then a very extensive study of the fuel supplies of the country has been carried on. Dr. Holmes, the director of this branch; Professor Lord, of the Ohio State University, in charge of the chemical work; Professor Breckenridge, of the University of Illinois, in charge of the boiler tests, and Professor Fernald, of Case School of Applied Science, in charge of the gas producer and gas engine tests; are all members of this society. The results obtained by these men, all of them engineers, have been of an astonishing character. It has been found that the fine coal, the refuse of mines and breakers, hitherto regarded as of little value and sold at an extremely low price, can be made into briquettes at a comparatively low cost and it is then as valuable as the finest coal that can be obtained. It has also been found that many non-coking coals can, by proper methods, be coked as readily as the best coking coals of Pennsylvania. These two results alone are worth many times as much as this bureau has cost the government, for certain manufacturing industries must have coke for fuel and in some sections it has been necessary to bring the coke from long distances because no coking coal was at hand, although large supplies of other coal were easily obtainable.

But perhaps the most wonderful results from these experiments have come through the investigations in regard to the use of coal in the gas producer and the gas engine. With the old processes we do not obtain on the average more than five per cent. of the heat value of our coals. The steam engine utilizes from four to ten per cent., but the

gas producer and the gas engine utilize from eleven to eighteen per cent. Coal converted into gas produces, then, two and one half times as much power as when burned under a boiler. The best Pocahontas coal under a boiler was found to produce .28 H. P. per pound of coal per hour, while with a gas producer the same amount of coal produced .96 H. P., or 3.34 times as much as when used in the ordinary way. A lignite which would produce only .01 H. P. per pound of coal per hour when used under a boiler produced .35 H. P. when used in a gas producer. A still more interesting fact is that the best Pocahontas coal used under a boiler produced .28 H. P. per pound per hour while a lignite in a producer gave .30 H. P. Thus, lignite turned into gas gave more power than the best coal when used under a boiler. These results indicate that there is fuel in all parts of the United States which can be used to produce power through the gas producer and gas engine, so that the amount of valuable fuel for power purposes has been increased many fold by the work of the Technologic Branch.

It is true that these results, while they show a great improvement over ordinary methods, look small compared to what should theoretically be obtained. Even the gas engine under the most favorable conditions does not utilize over eighteen per cent. of the heat value of the coal. There is still a great opportunity for the scientific man and the engineer to devise methods by which a larger per cent. of the energy of our fuels can be utilized. And the engineer has an important work to do in connection with the results already obtained. The gas engine has been in use in Europe for a number of years and is now being introduced into this country. There are some installations where the horse power runs into thousands, but these are isolated and are principally in connection with steel plants. The average manufacturer hesitates to install a gas engine because he fears that he can not depend upon it every day as he can upon the steam engine and because he knows that it can not be operated by the same engineer who can operate his steam plant. The steam engine is so simple and has been in use so long that it is very easy to make repairs upon it and it does not take very long comparatively to train a man to use it. The gas engine is more complicated, is not as well understood and at present there are very few men who are experienced in its use. The greater initial cost of the gas plant, the cost of operating and the feeling which the manufacturer has that it is unreliable will retard its use, but if our mechanical engineers, and especially if our engineering colleges, will make the thorough study of this question which it deserves, there is no doubt that within a few years the gas engine will practically supplant the steam engine. The manufacturer wants power and he wants it as cheaply as it can possibly be obtained. If a new form of prime mover will develop two and one half times as much power as the old without too much initial cost or expense of maintenance, the manufacturer will rapidly install the new form. I believe our engineering colleges should install gas plants and make a thorough and systematic study of their use from day to day. In this way their faults can be remedied and through published reports the manufacturer can be made to feel that they are reliable. At the same time it will be of immense benefit to the students in the mechanical engineering departments to have a thorough training in the principles and the use of this new form of engine.

IRON AND STEEL

This is an iron age. A nation's industrial progress is determined by the amount

of iron ore it uses. Gold, silver, tin, lead and many other metals, while useful, could be dispensed with, but iron and copper are indispensable at this stage of the world's progress, and of these two iron is by far the more necessary and the more useful. In 1907 fifty-three million tons of iron ore were mined and up to this time seven hundred and fifty million tons had been mined in this country. The total amount of iron ore available in the United States is about as follows: In Lake Superior, one billion five hundred million tons; southern district, two billion five hundred million tons; other parts of the United States, five billion tons; or a total of about ten billion tons. The highest grade is found in the Lake Superior district and hence this ore is in the greatest demand. In 1907 forty-four million tons were mined in this region, and with the present increase in consumption the supply will be completely exhausted by 1940 unless new deposits are discovered. Up to the present time one thirteenth of the original supply of iron ore in the United States has been used. At the present rate of exhaustion the total amount in the whole country will be used up before the end of the present century. This includes, however, only that supply which is of a high enough grade to be worked at the present time. After that it will be necessary to use lower grades of ore or we must do what so many European countries do—import from other places. This, of course, would be a great blow to our material prosperity. We have held our position in the industrial markets for iron and steel products on account of the abundance of our iron and coal and the consequent cheap price of both. When it becomes necessary to import either coal or iron, the cost of manufacture will largely increase, and unless conditions are different from those at present, we shall no longer be an exporting nation. It will be necessary for the engineer to use all of his ingenuity and skill to avert the commercial and industrial disaster which will inevitably come when the supply of iron ore is exhausted. This may be done, perhaps, by new methods which will make it possible to use a lower grade of ore and yet obtain the manufactured product at the same price as at present. New alloys of iron will undoubtedly be discovered by the engineer which will make it possible to obtain the present strength for machines and structures with the use of less material, thus decreasing the amount of ore used. As concrete reinforced by steel takes the place of steel structures, a still greater saving in iron will be the result. This is inevitably coming, for the progress in this direction during the past few years has been astonishing. The engineer is deeply concerned with methods of transportation and by substituting water transportation for rail transportation the saving in steel is very great, for the same load can be carried by the former with one third the steel in the original plant that is necessary when loads are carried by rail.

RECLAMATION OF LAND

The problem of maintaining the fertility of the soil and of enriching the worn-out farming lands of the country is one which belongs to the scientific agriculturist and not to the engineer, but there is one question connected with the agricultural interests of the country with which the engineer is vitally concerned—that is the reclamation of the arid and swampy regions. When the population of a country is sparse people seek the richest farming lands. They use the most exhaustive and least scientific methods of agriculture and the soil is soon depleted, but they are indifferent to this because there are large areas not in use and they can move from the worn-out farm to a new section. But as popula-

tion increases the richest lands are rapidly absorbed, those of second and third grade must then be used and in the end all the fertile soil of the country is under cultivation. After this, if population is to grow, more scientific methods of agriculture must be adopted or the hitherto useless land must be converted into fertile areas. The useless land consists of mountainous, desert and swampy regions. As a rule, the mountainous districts are not available for agriculture, though they may be for forestry. The desert land can in many cases be reclaimed by irrigation and the swampy land may often be reclaimed by drainage. Both of these processes, irrigation and drainage, are essentially within the province of the engineer and it is due to his efforts that so much fertile soil has been added to our national domain. Eight million acres have already been irrigated and in the next twenty-five years it is estimated that twelve million acres more may be reclaimed. We have in the United States eighty million acres of swampy land, of which twelve million have already been drained and twenty million more may be drained in the future. This will enable us to raise a food supply for many millions of people and hence population can grow to this extent. But the problem of reclamation is only a part of the greater problem of the food supply of the nation and this does not belong to the engineer.

INLAND WATERWAYS

The forests, water power, irrigation and inland navigation are more or less connected. The cutting away of the forests has been the cause of severe floods during certain sections of the year and very low water in the streams during the rest of the year. This has been detrimental to navigation and to the successful use of water power. Some streams are available, both for irrigation and water power and it is a question which of these is of the greatest value. If the water in a stream is used for irrigation it can not be used for water power and hence only one of these methods of utilization is available. Some streams can be used for power and also for navigation. The water which is used for power is not destroyed, but is turned back into the stream after its energy of motion or position has been used. The dams and other works necessary for the utilization of power form an impediment to navigation, but can be overcome by canals. Thus it seems that the question of the use of water must be studied from several standpoints and the final solution of the problem will depend upon a number of different facts.

The United States possesses an unrivaled natural system of waterways. Professor Johnson says that at present we have 25,000 miles of navigable streams and there is as much more that can be made navigable. There are 1,410 miles of navigable waters in the Great Lakes and we have 2,120 miles of canals. There are 2,500 miles of waterways in sounds, bays and bayous on the Atlantic and Gulf coasts. These can all be made into a splendid inland system by the construction of a comparatively few miles of canals. On account of the absence of these canals only a very small part of this natural water route is at present utilized. In view of the importance of our waterways very little has so far been done. We have wasted our natural routes of travel by the destruction of forests, by allowing our streams to fill up with sand, and by our neglect to use those which are still available. It is much cheaper to transport heavy material by water than by rail and the great advantage which comes from the proper use of waterways is shown wherever the government has given the necessary aid. The most striking evidence of the value of work properly directed is seen in the Great Lakes, where a hundred million dollars has

been spent. The water in the lakes is deep enough for the largest vessels, but the rivers and straits connecting them naturally had only from eight to twelve feet of water. This has been increased through government appropriations to twenty-one feet, and now this body of Great Lakes forms one of the grandest pieces of navigable water known in the world. In 1889 twenty-five million tons passed through this system and in 1906 this had increased to seventy-six million tons. In 1907 it was eighty-three million tons and the increase will undoubtedly go on. In the Mississippi Valley two hundred and eight million dollars has been spent, but very little of it has gone for navigation. The larger part has been spent in jetties and dikes and so forth, necessary to prevent the loss of property and of life. So little has been done in the greater part of the Mississippi Valley that the tonnage has decreased during the past twenty years. The Inland Waterways Commission has done a most valuable work in showing the possibilities of our navigable streams, lakes and bays. It is to be hoped that congress will make the appropriations necessary to make this body permanent and that its recommendations will receive favorable consideration. In England, France and Germany the waterways have received far greater attention than here. Although these countries are much smaller than the United States a very much larger proportion of the total tonnage passes through the rivers and canals. We should take a lesson from these nations and learn to give this subject the proper amount of attention. The larger use of our waterways will not decrease the amount of railway traffic. The railways now have more than they can do and they have found great difficulty in raising money sufficient to increase their trackage and their transportation facilities.

Railroad transportation can only take place over a pathway which has been especially prepared and which has been laid with steel rails. Water transportation does not need this. A natural pathway is ready and it is only necessary to provide the vessels to carry the traffic. This makes the cost of transportation by water very much less than that by land. The initial cost is less and the cost of maintenance is less. Navigation has decreased during the past few years in many sections because the streams are shallow and the loads carried have been very small. As the railroads have reached into the districts formerly served by boats, the rapidity of transportation and the possibility of carrying large loads have decreased the cost below that of water service. If these streams, however, can be given the proper depth so that larger vessels can be used and greater loads carried, the transportation by water will be resumed. The whole question of water transportation belongs to the engineer. Whatever has been done in the past has been planned and carried out by him and all improvements in the future must be his work.

CONCLUSIONS

I have presented in a very imperfect way the present state of our natural resources and have suggested some of the steps which should be taken to conserve them. There is nothing original in this. The facts have been gathered from government reports and papers written by experts in each of the several divisions of this question. The point which I had in mind during the preparation of the paper and to which I wish to give especial emphasis is that this work of conservation is the work of the engineer. I am inclined to think that in some cases the statements in regard to the destruction of our natural resources have been overdrawn and that they will not be totally exhausted in as short a period as some seem to believe, but there is no doubt

that the question is a grave one and that it should be faced before it is too late. We should try to avoid waste and unnecessary destruction and we should also try to make the best possible use of all of our resources. It will be the work of the engineer to accomplish both of these objects, and it will also be his province to determine new ways of accomplishing results now so wastefully performed. In the past the engineer has been concerned in getting results. If the results were obtained, the waste and destruction of the natural product have scarcely been considered, but in the future, economy of the natural product as well as economy in the final result must receive careful attention. I believe the engineers of the country are capable of solving these problems, and that if they are given the necessary governmental and private aid that the problem of the conservation of our natural resources will be solved.

The engineering colleges of the country will also have a share in this work. They are training the engineers of the future and from now on they must train them with this problem in view. They must not only give them the principles of engineering practise, but they must show them how the work of the engineer can be carried out with a view of transmitting to our posterity the natural resources in, so far as possible, an unimpaired condition. As has been pointed out in this paper, the conservation of some of our natural resources must be accomplished through new inventions. This means that the engineer of the future must be able to do more than the simple engineering work which comes to him from day to day. He must be so thoroughly trained in the principles of science and applied mechanics that he will be able to discover new processes and accomplish old results in new and more economical ways. He must be taught more thoroughly than ever before how to unite theoretical and practical knowledge. In short, he must be able to think along scientific and engineering lines. This is the most difficult thing which the engineering college has to teach. There are so many subjects in the curriculum, so much that is necessary for the engineer to learn, that he has not had the proper time to digest this mass of material. I feel convinced that this problem of teaching the student to think, of giving him the power to solve things for himself, has for many years received the earnest attention of the members of this society, but in view of the problem which I am discussing to-day, I wish to urge upon all who teach in our colleges the importance of giving it still more attention. Engineering science is progressive, the subjects taught in our engineering schools are alive and not dead. We shall grow, not only in knowledge, but in methods, and we shall accomplish the results we ought to accomplish and solve the problems presented to us.

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Cleveland, Ohio

THE INCREASING IMPORTANCE OF THE RARER ELEMENTS[1]

In many of our courses in inorganic chemistry we have placed in view charts upon which the names of some eighty elementary substances appear. For one reason or another more than one half of these elements have remained to the majority of students little more than names; whereas to-day we find many of them contesting positions of importance with the better known elements on account either of industrial utility or of pure scientific interest. May I define then the rarer elements not as those necessarily rare in occurrence but rather as those not always

[1] Address of chairman of the Inorganic Section at the New Haven meeting of the American Chemical Society, June 30, 1908.

taken up in a general course in inorganic chemistry.

In considering briefly the reasons why it would seem best to remove at least a number of these elements from the confines of my definition I shall in general limit myself to the presentation of certain facts and figures gathered from the record of the last half-decade.

Hillebrand in discussing the analysis of silicate and carbonate rocks mentions Ti, Zr, V, Li, Ta, Cb, Be, Th, Ce, and the rare earths as possible ingredients of the silicate rocks, and adds in regard to Th, Ce and the rare earths that "they are probably more common as constituents of silicate rocks than has generally been supposed; and A. A. Noyes and his associates in their new system of qualitative analysis have included Tl, Pt, Au, Se, Te, Mo, Be, U, V, Ti and Zr.

For convenience the periodic grouping will be followed in the consideration of the elements which we wish to discuss.

In group (1) rubidium and cæsium clearly come under our definition, and possibly also lithium. Lithium, as already stated, is an ingredient to be reckoned with in rock analysis, while its importance in water analysis is shown by its presence in over forty samples of water from different parts of the world in amounts varying from traces to one per cent. In Clarke's data of geo-chemistry, from which these figures were taken, we find rubidium mentioned as present in about twenty samples of water, cæsium being more rare.

The last report of the United States Mineral Resources shows an output of about 2,200 short tons of lithium minerals since 1903 with a value of about $40,000.

During the past five years the greater part of the work upon these elements has been concerned with the formation of new compounds. It is perhaps of interest to note in this connection that iron alums of selenic acid containing cæsium and rubidium have been prepared, while the corresponding ammonium and potassium salts have not been successfully produced.

In group (2) we have the elements beryllium and radium. Concerning the former, I need add no word after the masterly paper upon "The Vagaries of Beryllium,"[2] given before this body a year ago by Chas. L. Parsons. To the student of pure chemistry, if not as yet to the technical chemist, the element offers most interesting problems. May we not hope that a more extended study of the production and properties of this metal of low specific gravity will make possible some important application in the arts.

It is not the purpose of this paper to take up the subject of radium and radioactivity more than to mention the stimulus which this branch of work has given to the study of uranium and thorium minerals and of their natural associates.

In group (3) we find yttrium and certain members of the cerium group. These bring us to the consideration of the rare earth group, comprising within its ever-growing boundaries about sixteen names which seem at times to be almost the despair of the chemical housekeeper who may wish to file away each element in its appropriate group-cupboard of the periodic system.

Notable among the aids to the worker in this field during the past few years have been the publication of Böhm's "Darstellung der Seltenen Erden," Leipzig, 1905, in two volumes of about 500 pages each, Schilling's "Vorkommen der Seltenen Erden," Munich, 1904, and Meyer's "Bibliographie der Seltenen Erden," Hamburg, 1905. Among the voluminous papers describing excellent work in this

[2] Science, N. S., Vol. XXVI., No. 670, pp. 569–74, November 1, 1907.

field by many distinguished chemists, we note in particular Urbain's recent separation of ytterbium into lutecium and neoytterbium, a separation previously indicated by Welsbach, and the still more recent work of James upon the bromate separation of yttrium earths, and the arrangement of the rare earth separation methods into a systematic scheme of analysis.[3] This latter piece of work certainly reflects great credit upon this painstaking investigator, and I will venture the prediction that if we keep our eyes upon Urbain and James we shall be rewarded by something more than mere spectacular spectroscopic speculations. Marc in a recent paper upon the "Development of our Knowledge of the Rare Earths and their Significance" calls attention in closing to a reference by Crookes to the rare earth minerals as a cosmic rummage chamber, and significantly adds that often the most important facts concerning the history of a family are to be found in rummage chambers.

Since thorium and zirconium are included by Böhm among the rare earths and are closely associated with them, these elements will be taken up at this point. The mention of thorium in this connection is certainly most appropriate, for it can not be questioned that the use of thorium nitrate in the preparation of the mantles used in incandescent gas lighting, and the development of this great industry have given a mighty impetus to the study of the rare earths.

A few figures will give us some idea of the growing importance of thorium and its chief mineral source, monazite. In 1902 the production of monazite sand in the United States and Brazil amounted to 3,500,000 pounds, with a value of $324,-000; while the last report, that of 1906, shows a production of 10,450,000 pounds, with a value of $630,000—an increase in value of almost 100 per cent. In the United States alone, and almost exclusively from Henderson County, N. C., the value of monazite sand produced has increased from about $65,000 in 1902, to about $153,-000 in 1906. Of interest and importance in this connection is the new mineral thorianite discovered in Ceylon in 1904. It carries from 70 per cent. to 80 per cent. of thorium oxide, and the report of 1905 shows an export of about 18,000 pounds, valued at about $24,000.

Helpful to the student of thorium are the works of Böhm and Schilling already mentioned, as well as the "Index to the Literature of Thorium" by Jouet, published by the Smithsonian Institution in 1903.

In considering zirconium we would note in particular the work of Rosenheim on the zirconyl salts and the investigations of Wedekind, who finds a practical method for the production of zirconium carbide, a compound resistant to air, water, and hydrochloric acid, and said to be an excellent conductor of electricity. Ninety parts of this carbide with ten parts of the metal ruthenium have been made by Sanders into filaments for use in the zirconium lamp. A mixture consisting of eighty-five parts of zirconium oxide and fifteen parts of yttrium earth oxides of the higher atomic weights is used in the manufacture of the Nernst glowers. The production of zircon in this country, much of it obtained as a by-product from monazite concentrates, has not been large; as reported in 1906 it amounted to 1,100 pounds, valued at $248.

In connection with the subject of rare earths it is perhaps of interest to refer to the growing use of ceric and cerous compounds as oxidizing and reducing agents; to Barbieri's statement in regard to cerium salts as catalytic agents, their behavior being similar to that of manganese

[3] *Jour. Amer. Chem. Soc.*, XXX., 979, June, 1908.

salts, and to Weiss's application of "misch metal," a mixture largely of the cerium earth metals, to the reduction of the oxides of Mo, V, Nb and Ta. Since cerium is obtained in large quantities as a by-product in the preparation of thorium salts from monazite, its various applications are of special interest.

Of the elements gallium, indium and thallium little will be said. During the past five years, gallium has been mentioned but once in the *Zentralblatt,* and that on account of its occurrence in a Sardinian blend. Renz and Thiel abroad and Mather in this country have done interesting work upon the properties and salts of indium. Indexes to the literature of these two elements, by Browning, were published by the Smithsonian Institution in 1904 and 1905. Thallium, with its two distinct conditions of oxidation and its ease of detection by means of its characteristic flame spectrum, has offered an attractive field to the student of pure chemistry. Growing interest in it is indicated by an increase of 200 per cent. in the number of reviews dealing with that element in the *Zentralblatt* for 1907 as compared with 1903.

Passing to group (4) we find besides thorium and cerium, already mentioned, the elements titanium and germanium. Germanium, like gallium, seems to have attracted little attention of late. An index to the literature of germanium, by Browning, was published in 1904 by the Smithsonian Institution.

Titanium can not be regarded as of rare occurrence, but I think that most chemists will allow it to be classed as a rare element under our definition. Hillebrand states that as far as his personal experience goes, titanium is entirely absent from no igneous, metamorphic, or sedimentary rock of a more or less siliceous character, and Clarke tells us that of 800 igneous rocks analyzed in the laboratory of the Geological Survey, 784 contained titanium. The element is now generally considered to stand tenth in order of abundance in the earth's crust as far as that has been explored, being more abundant than copper, lead or zinc. Considering these facts it is with satisfaction that we find titanium gradually taking its place among the useful elements. Until quite recently the presence of one per cent. or more of titanium in iron ores was considered sufficient to make them undesirable on account of the formation of pasty slags in the metallurgical process. This difficulty, according to Rossi,[4] can be avoided by judicious regulation of fluxes and temperatures. The addition of titanium to cast iron has been shown to increase its strength, and the presence of the same element in steel seems not only to augment the tensile strength of the steel but also to raise its limit of elasticity. This property of titanium has developed the production of ferro-titanium for use in the manufacture of steel.

According to the last volume of the "Mineral Resources," titanium is being used to a certain extent as a filament for incandescent electric lamps, and has the advantage over tungsten of a higher melting point and higher electrical resistance. Rutile, titaniferous magnetite, and titanium carbide are all finding some use as electrodes with carbon blocks in arc lamps. Other commercial uses of titanium are found in the employment of rutile for giving porcelain tile a yellow color and for coloring artificial teeth; of titanous chloride and titanous sulphate as mordants and of titanous potassium oxalate as a mordant and yellow dye in the treatment of leather. Recently we have seen quite frequent references to the applica-

[4] Rossi, A. J., *Trans. Am. Inst. Min. Eng.*, Vol. XXI., 832.

tion of titanous salts as reducing agents in volumetric analysis.

"Mineral Resources for 1906" reports a small production of rutile, chiefly from Virginia, as against no production in 1903; also large deposits of titaniferous iron ores from North Carolina, Wyoming and the Adirondack region. The constant advances made in the metallurgy of this element seem to assure an advancing prominence.

Passing to group (5) we find first on our list the element vanadium. Few of the elements which we have to consider are of such general interest. Its five distinct conditions of oxidation, with their salts, well-defined in most cases, furnish the chemist with a fascinating field for experimentation, as witness the many volumetric processes which concern themselves with this element, and the voluminous published work upon the salts of tetra- and trivalent vanadium.

Among the uses which have been found for vanadium are its employment in the making of a photographic developer, a fertilizer for plants, coloring material for glass, and with anilin, a black dye. Vanadyl phosphate has been found to behave physiologically like potassium permanganate. Vanadic acid (V_2O_5) is employed as a substitute for gold bronze, in the making of a water-proof black ink with tannic acid, in the manufacture of sulphuric acid by the contact process, and as a catalyzer to accelerate oxidation processes, such as the oxidation of sugar to oxalic acid, of alcohol to aldehyde, and of stannous to stannic salts.

Probably of more importance than any of these uses of vanadium is its employment in the manufacture of steel, as described in the pamphlets written by Mr. J. Kent Smith, of the American Vanadium Co. From these we learn of the remarkable elasticity and tensile strength of steels containing from .15 to .35 of one per cent. of vanadium introduced as ferro-vanadium, an alloy containing about 30 per cent. of vanadium. This important commercial use of the element has stimulated the search for its ores, a search which has resulted in our own country in several discoveries, chief of which is that of carnotite in Routt County, Colorado. Of interest in this connection are the extensive deposits of vanadium ore discovered in Peru less than two years ago, and found to contain a sulphide, essentially VS_4, named by Hewett patronite, and found by Hillebrand to contain from 18.5 per cent. to 19 per cent. of vanadium. Of value to the student of this element are three recent pamphlets, "Das Vanadin und seine Verbindungen," by Ephraim, 1904, "Die Literatur des Vanadins," by Prandtl, 1906, and "Le Vanadium" by P. Nicolardot, published by Gauthier-Villars, Paris.

Probably no one of the elements which we have to consider has made a more phenomenal leap from practical obscurity to comparative prominence than has tantalum. In the index of the *Zentralblatt* for 1903 we find no mention of this element, while the index for 1905, the year of the first application of tantalum to incandescent lighting contains twenty references to it. The use of the tantalum filament as a substitute for carbon is certainly an interesting step in the development of incandescent electric lighting. The tantalum lamp produces a light of one candle power for every two watts of electrical energy, as against three and one tenth watts required by the ordinary carbon filament. Tantalum is said to be as hard as steel and as resistant to chemical action as gold. These qualities are responsible for a patent for its use in pens.

A catalogue[5] of the mineral sources of

[5] *Zeitsch. f. angew. Chem.*, 1905.

the element, prepared by Schilling, shows over three hundred and fifty analyses of tantalum minerals comprising about forty species which occur widely distributed throughout the world. In our own country, South Dakota and Colorado reported a commercial production of the ores in 1906, and fair sized deposits have been found in North Carolina, Texas, and elsewhere. Last year ore carrying 80 per cent. of Ta_2O_5 was sold at from three to four dollars a pound. Since one pound of the metal will make some tens of thousands of lamp filaments, material for the new lights would seem to be plentiful and cheap.

Notable as a matter of purely chemical interest is the work of Edgar F. Smith and his associates upon the compounds of tantalum and columbium or niobium.

In Group (6) we have the elements Mo, W, U, Se and Te. Molybdenum, like vanadium, on account of its many well-defined oxidation stages presents interesting problems in analytical and synthetical chemistry; and the last half decade contains the record of considerable work upon the complex organic and inorganic compounds. The ores are in steady demand, chiefly for the production of ammonium molybdate, which is used in phosphate determinations, in fire-proofing, in coloring pottery glazes, and as a germicide. Molybdic acid is employed to some extent in dyeing. The metal is used in steels, but on account of its low fusing point can not be employed in filaments for incandescent lighting.

Few of the so-called rarer elements occupy so prominent a position at the present time as tungsten. Its production in this country alone has increased from about three hundred short tons, valued at about $44,000 in 1903, to over nine hundred short tons, valued at about $350,000 in 1907—an increase in amount of 200 per cent. and in value of 600 per cent. The principal source of tungsten ore in this country has been the deposits of wolframite in Boulder County, Colorado, while Arizona, Montana, New Mexico, Washington and Idaho have furnished some ore. Recently deposits of hübnerite in the Snake Range, Nevada, and of wolframite near Raymond, Cal., have been investigated. Ores are also mined in Europe, Africa, South America and Australia.

Without doubt, the most spectacular use of tungsten at present is in the filaments of the incandescent electric light bulbs. This metal with its melting point over 3,000° C., a little higher than that of tantalum, makes a lamp which has the advantage of giving one candle power of light per 1.25 watts of electrical energy, as against 2 watts in the case of the tantalum lamp, and which has a life of one thousand or more hours as against about five hundred hours for the carbon and tantalum lamps. The chief disadvantage of the tungsten lamp is the extreme fragility of the filament, which makes losses in transportation large unless the packing is very carefully done. Tungsten-titanium, tungsten-tantalum and tungsten-zirconium lamps have been recently suggested, but so far as I can learn they are still in the experimental stage.

Among the better and longer known uses of tungsten are its employment in ferrotungsten for the hardening of steels, and in sodium tungstate for fireproofing draperies and as a mordant in dyeing. Certain salts are also used in weighting silks. The high melting point of the element has suggested its possible use in the manufacture of crucibles.

Notable among the recent purely chemical work upon this element has been the study of the complex tungstates with titanium, zirconium and thorium, and the double polytungstates of alkali earths with the alkalies. The formation of the silicides of

molybdenum and tungsten by treatment with copper silicide or by fusing the oxides with silicon dioxide and aluminum is important. The interest which tungsten has aroused during the past five years is partly shown by an increase of 500 per cent. in the number of articles reviewed in 1907 over 1903.

Uranium and its ores, *i. e.*, pitchblende, carnotite, autunite, etc., seem to owe their chief prominence at present to the radioactive material associated with them, although uranium salts are used in the manufacture of certain velvety-black pottery glazes and greenish-yellow iridescent glasses. An interesting subject for further analytical work is the separation of uranium and vanadium in carnotite; a commercial process with this end in view has recently been developed by Haynes and described in the last volume of "Mineral Resources." The chief source of uranium in this country is the carnotite deposit of Colorado.

The element selenium has the peculiar property of being, under the influence of light, a fairly good conductor of electricity, while in the dark it is practically a nonconductor. In the latest edition of "Mineral Resources of the United States," Hess mentions the following purposes for which this property of selenium has been used in the construction of apparatus, namely: for automatically lighting and extinguishing gas buoys, for exploding torpedoes by a ray of light, for telephoning along a ray of light, for transmitting sounds and photographs or other pictures to a distance by means of telegraph or telephone wire, for measuring the quantity of Roentgen rays in therapeutic applications. Upon a more general demand for any or all of these instruments depends very largely the demand for selenium. Up to the present time there has been practically no production of selenium in the United States outside of small quantities existing in residues resulting from the refining of copper by electrolytic methods. The recent work upon selenium has been largely in the line of the formation of new compounds. A monograph by Marc[6] upon the "Physical and Chemical Properties of the Element" has recently appeared.

If the element tellurium had no other reason for prominence, its anomalous atomic weight and its mineralogical association with gold would serve to give it an important place. Lenher in a recent article has briefly discussed about forty years of combined work by Brauner, Baker and Bennett, Norris and himself upon the "Homogeneity of Tellurium," and has arrived at a conclusion in favor of homogeneity and of an atomic weight of 127.55. About the same time Marcwald reached a similar conclusion regarding homogeneity, but gave as the result of his work an atomic weight of 126.85, a value slightly below the accepted weight of iodine, 126.97. Marcwald's method was the heating of orthotelluric acid (H_6TeO_6) and the weighing of the tellurium dioxide obtained.

The close association of tellurium with gold has, as already intimated, brought about its possibly unenviable prominence. A careful study of the problems connected with the satisfactory handling of telluride ores has recently been published by Hillebrand.

One can scarcely speak of the growing prominence of such elements as gold and platinum, but a few figures in regard to their production in our country may be in point. The output of gold in 1906 was $94,000,000 as against $74,000,000 in 1903, and the output of platinum in 1906 was valued at $45,000 as against $2,000 in 1903.

[6] "Die Physikalisch-Chemischen Eigenschaften des metallischen Selens," Hamburg and Leipzig, Leopold Voss, 1907.

The value of the platinum imported in 1906 was nearly $4,000,000, or double the value of that imported three years earlier.

The platinum deposits in this country are to be found in Oregon, California, Washington, Utah and Nevada.

The separation and the complex compounds of the platinum metals continue to offer interesting problems to the chemist, and the able researches of Howe and of Gutbier have added much to our knowledge of this field. Palladium and iridium have found uses in the construction of fine apparatus. Osmium has long been used as a stain in microscopic work, and more recently as a filament for incandescent electric lamps. Ruthenium, as already stated, has been mixed with zirconium carbide for the filament used in the zirconium lamp.

In conclusion, allow me to refer to an address by Dr. H. Landolt given last November at the fortieth anniversary of the founding of the German Chemical Society upon the "Development of Inorganic Chemistry" during the past forty years.[7] In this address advancement along four lines was especially noted: (1) The discovery of the elements Ga, Sc, Ge, Sm, Gd, Tm, Eu, Nd, Pr, Ar, Xe, Ne, Kr and He; the discovery of radium; and the study of the phenomena of radioactivity, which has taught us that elements are undecomposed but not undecomposable bodies. (2) The realization of a compilation of international atomic weights, a work in which Dr. Clarke of the American Chemical Society has had a large and honorable share. (3) The preparation of elementary substances by the electric furnace and by the Goldschmidt process, and the study of allotropic modifications of elementary substances with special references to colloidal forms. (4) The formation of such compounds as the carbides, hydrides, silicides, complex acids and metal ammonium bodies.

In all of these lines of chemical progress, I am sure you will agree with me that the *rarer elements* have played an important rôle.

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SCIENTIFIC NOTES AND NEWS

THE Geological Society of America has altered the plan of holding its winter meeting at New Haven and will meet at Baltimore in convocation week in conjunction with the American Association for the Advancement of Science.

THE fourth annual meeting of the Southern Society for Philosophy and Psychology will be held in Baltimore during convocation week, December 28–January 2, in affiliation with the American Association for the Advancement of Science, the American Psychological and Philosophical Associations and other societies.

ON the occasion of the seventy-fifth anniversary of Haverford College, Dr. Theodore W. Richards, of the class of '85, professor of chemistry at Harvard University, gave an address entitled "The Relation of Modern Chemistry to Medicine." Professor Richards and Dr. James Tyson were among those on whom the honorary degree of doctor of laws was conferred.

PRESIDENT CHARLES R. VAN HISE, of the University of Wisconsin, received the degree of doctor of laws from Williams College on the occasion of the inauguration of President Garfield.

THE delegates from the United States to the International Conference on Electrical Units and Standards now in session in London are Dr. Henry S. Carhart, professor of physics at the University of Michigan; Dr. S. W. Stratton, director, Bureau of Standards, Washington, and Dr. E. B. Rosa, physicist of the bureau.

AT the general meeting of the German Meteorological Society at Hamburg in Sep-

[7] *Ber.*, XL., 4627, 1907.

tember, to celebrate the twenty-fifth anniversary of its foundation, Professor A. Lawrence Rotch, director of the Blue Hill Observatory, Massachusetts, was elected an honorary member of the society and Professor F. H. Bigelow, of the United States Weather Bureau, a corresponding member.

The Italian Society of Sciences has awarded its biennial mathematical prize to M. Giuseppe Picciati, of the University of Padua.

Sir George Darwin and Professor Larmor have been appointed electors to the Isaac Newton studentships at Cambridge University.

Dr. W. Engelmann, professor of physiology at Berlin, will retire from active service at the close of the present semester.

Dr. P. Heinrich has retired from the directorship of the Agricultural Experiment Station at Rostock.

Mr. F. G. Clapp, geologist of the U. S. Geological Survey, engaged in investigations and preparation of reports on coal, oil, gas and artesian waters, has resigned in order to take up expert practise.

Mr. Horace V. Winchell has resigned his position as chief geologist for the Great Northern Railway Co., and has opened an office for general practise.

Miss Wilman, of the South Africa Museum, has been appointed curator of the Alexander McGregor Memorial Museum, Kimberley, and will take up her duties by the end of February next.

Dr. Sven Hedin, the Swedish explorer, sailed from Bombay for Yokohama on October 13. He expects to have finished his book on his Tibetan travels next May.

Professor William James returned on October 16 to Cambridge from England, where he had gone to deliver a series of eight lectures at Oxford on "The Present Position of Philosophy."

Dr. Smith Ely Jelliffe and family have left New York for a year's stay in Europe. Dr. Jelliffe anticipates working in the Psychiatric Clinic with Professor Ziehen while in Berlin and with Dr. Oppenheim, of the same city.

Dr. Daniel Vergara Lope, professor of physiology in the University of Mexico, lectured at the George Washington University, October 16, on "The Physiological Effects of High Altitudes on Man."

There was held at the Sorbonne in Paris, on October 4, a meeting in memory of the great chemist, Marcellin Barthelot. M. Raymond Poincaré made an address on his work, and was followed by M. Fallière, president of the Republic. M. Clemenceau, the prime minister, and M. Domergue, minister of education, were present.

Dr. Francis H. Snow, chancellor of the University of Kansas from 1889 to 1901, and for many years at the head of the department of entomology, died on September 20 at the age of 68 years.

M. Alphonse Boistel, for forty years professor of commercial law in the University of Paris, known to students of the natural sciences for his work in botany and geology, has died at the age of seventy-one years.

We regret also to record the death of Mr. Bennett H. Brough, secretary of the British Iron and Steel Institute, and of Mr. J. T. Cart, an English student of applied chemistry.

The autumn meeting of the Iron and Steel Institute of Great Britain was held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell.

Lectures will be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

October 17—"Edible and Poisonous Mushrooms," by Dr. W. A. Murrill.

October 24—"Wild Autumnal Flowers and Fruits," by Dr. N. L. Britton.

October 31—"Letchworth Park and the Falls of the Genesee," by Mr. George V. Nash.

November 7—"Plant Distribution as interpreted by Geology," by Dr. Arthur Hollick.

November 14—"Botanical Cruises in the Bahamas," by Dr. M. A. Howe.

November 21—"The Rubber Plants of Mexico," by Dr. H. H. Rusby.

The following is the provisional program of the Royal Geographical Society for the present session:

November 2—"Unexplored Western Asia," by D. G. Hogarth.

November 16—"Some Aspects of the River Paraná, and its Watershed: an Economic Survey," by W. S. Barclay.

November 30—"The Panama Canal in 1908," by Dr. Vaughan Cornish.

December 7—Possibly Dr. Sven Hedin on his latest expedition in Tibet.

December 14—"Fifty Years of Nile Exploration and some of its Results," by Sir William E. Garstin, G.C.M.G. (The jubilee of Speke's discovery of the Victoria Nyanza.)

Other papers which may be expected after Christmas are the following:

"My Recent Expedition in Central Asia," by Dr. M. A. Stein.

"Survey and Exploration in the Ruwenzori and Lake Region, Central Africa," by Colonel R. G. T. Bright, C.M.G.

"The Danish Northeast Greenland Expedition," by Lieutenant A. Trollé.

"Bhutan: the Results of Two Expeditions," by John Claude White, C.I.E.

"The Western Pacific," by Sir Everard F. im Thurn, K.C.M.G., C.B.

"Across the Sahara from Tripoli to Timbuktu," by Hanns Vischer.

"The Colorado Cañon; Some of its Lessons," by Professor W. M. Davis.

"A Recent Journey in North Central Arabia," by Captain S. S. Butler.

"South America and its Antarctic Relations," by G. F. Scott Elliot.

"Earthquakes and Geography," by R. D. Oldham.

"The Geographical Conditions affecting the Development of the British Empire. II. Australia," by Professor J. W. Gregory, F.R.S.

THE New Zealand Shipping Company's steamer *Ruapehu,* which left Plymouth on October 3 for New Zealand, carried a large consignment of stores for the use of Lieutenant Shackleton's Antarctic expedition. The liner will reach Wellington in the middle of November. Other articles will be sent to the relief ship *Nimrod* at Lyttelton, and these, it is expected, will reach the explorer by New Year's Day.

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tember, to celebrate the twenty-fifth anniversary of its foundation, Professor A. Lawrence Rotch, director of the Blue Hill Observatory, Massachusetts, was elected an honorary member of the society and Professor F. H. Bigelow, of the United States Weather Bureau, a corresponding member.

The Italian Society of Sciences has awarded its biennial mathematical prize to M. Giuseppe Picciati, of the University of Padua.

Sir George Darwin and Professor Larmor have been appointed electors to the Isaac Newton studentships at Cambridge University.

Dr. W. Engelmann, professor of physiology at Berlin, will retire from active service at the close of the present semester.

Dr. P. Heinrich has retired from the directorship of the Agricultural Experiment Station at Rostock.

Mr. F. G. Clapp, geologist of the U. S. Geological Survey, engaged in investigations and preparation of reports on coal, oil, gas and artesian waters, has resigned in order to take up expert practise.

Mr. Horace V. Winchell has resigned his position as chief geologist for the Great Northern Railway Co., and has opened an office for general practise.

Miss Wilman, of the South Africa Museum, has been appointed curator of the Alexander McGregor Memorial Museum, Kimberley, and will take up her duties by the end of February next.

Dr. Sven Hedin, the Swedish explorer, sailed from Bombay for Yokohama on October 13. He expects to have finished his book on his Tibetan travels next May.

Professor William James returned on October 16 to Cambridge from England, where he had gone to deliver a series of eight lectures at Oxford on "The Present Position of Philosophy."

Dr. Smith Ely Jelliffe and family have left New York for a year's stay in Europe. Dr. Jelliffe anticipates working in the Psychiatric Clinic with Professor Ziehen while in Berlin and with Dr. Oppenheim, of the same city.

Dr. Daniel Vergara Lope, professor of physiology in the University of Mexico, lectured at the George Washington University, October 16, on "The Physiological Effects of High Altitudes on Man."

There was held at the Sorbonne in Paris, on October 4, a meeting in memory of the great chemist, Marcellin Barthelot. M. Raymond Poincaré made an address on his work, and was followed by M. Fallière, president of the Republic. M. Clemenceau, the prime minister, and M. Domergue, minister of education, were present.

Dr. Francis H. Snow, chancellor of the University of Kansas from 1889 to 1901, and for many years at the head of the department of entomology, died on September 20 at the age of 68 years.

M. Alphonse Boistel, for forty years professor of commercial law in the University of Paris, known to students of the natural sciences for his work in botany and geology, has died at the age of seventy-one years.

We regret also to record the death of Mr. Bennett H. Brough, secretary of the British Iron and Steel Institute, and of Mr. J. T. Cart, an English student of applied chemistry.

The autumn meeting of the Iron and Steel Institute of Great Britain was held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell.

Lectures will be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

October 17—"Edible and Poisonous Mushrooms," by Dr. W. A. Murrill.

October 24—"Wild Autumnal Flowers and Fruits," by Dr. N. L. Britton.

October 31—"Letchworth Park and the Falls of the Genesee," by Mr. George V. Nash.

November 7—"Plant Distribution as interpreted by Geology," by Dr. Arthur Hollick.

November 14—"Botanical Cruises in the Bahamas," by Dr. M. A. Howe.

November 21—"The Rubber Plants of Mexico," by Dr. H. H. Rusby.

The following is the provisional program of the Royal Geographical Society for the present session:

November 2—"Unexplored Western Asia," by D. G. Hogarth.

November 16—"Some Aspects of the River Paraná, and its Watershed: an Economic Survey," by W. S. Barclay.

November 30—"The Panama Canal in 1908," by Dr. Vaughan Cornish.

December 7—Possibly Dr. Sven Hedin on his latest expedition in Tibet.

December 14—"Fifty Years of Nile Exploration and some of its Results," by Sir William E. Garstin, G.C.M.G. (The jubilee of Speke's discovery of the Victoria Nyanza.)

Other papers which may be expected after Christmas are the following:

"My Recent Expedition in Central Asia," by Dr. M. A. Stein.

"Survey and Exploration in the Ruwenzori and Lake Region, Central Africa," by Colonel R. G. T. Bright, C.M.G.

"The Danish Northeast Greenland Expedition," by Lieutenant A. Trollé.

"Bhutan: the Results of Two Expeditions," by John Claude White, C.I.E.

"The Western Pacific," by Sir Everard F. im Thurn, K.C.M.G., C.B.

"Across the Sahara from Tripoli to Timbuktu," by Hanns Vischer.

"The Colorado Cañon; Some of its Lessons," by Professor W. M. Davis.

"A Recent Journey in North Central Arabia," by Captain S. S. Butler.

"South America and its Antarctic Relations," by G. F. Scott Elliot.

"Earthquakes and Geography," by R. D. Oldham.

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water communication with the Lake of Geneva is impracticable. A Paris company has made proposals to the French Government for the construction of a barrage across the Rhone below Bellegarde, forming above stream a reach of 14 miles to the lake, and downstream a waterfall which it is estimated would yield 100,000 horsepower for transmission to Paris. The company further offers to construct the necessary facilities to enable vessels to pass through the dam. In this way navigation would be opened direct with Geneva. Associated with this project is one for the construction of a canal from Lyons to Arles. This canal would be 170 miles long, and would cost about $120,000,000, and it is understood that the municipality of Marseilles is considering the advisability of connecting this canal with that town by another canal to cost $16,000,000. If this scheme were put into execution Lyons, Marseilles and the Rhine would be placed in direct communication by means of the Rhone-Rhine Canal.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Grace M. Kuhn, widow of Hartman Kuhn, of Philadelphia, recently filed for probate in the Berkshire courts, Harvard University receives $175,000 to endow a department of biological chemistry in the memory of a son, Hartman Kuhn, who died several years ago.

The general council of Louisville has passed an ordinance which has been signed by the mayor, appropriating $25,000 from the general purpose fund for 1908, for the use of the Medical Department of the University of Louisville. The money is to be expended for laboratory equipment for the consolidated medical schools.

Mr. Jacob Sassoon has given about $330,000 to establish a central college of science in Bombay.

Dr. Henry Julian Hunter has left $70,000 to Sheffield University.

Statistics just compiled at the University of Wisconsin show that 417 graduates and former students have this year received appointments to the faculties of universities, colleges, normal schools, academies and high schools, or as superintendents of schools in 29 states and 7 foreign countries. Of the total number, 116 received appointments to the faculties of colleges and universities; 250 were appointed high school principals or teachers and superintendents of schools; 14 were appointed as instructors in normal schools; and 7 were appointed to college and normal schools in Alaska, Porto Rico, Philippines, Japan, Argentine Republic and Canada. Among the colleges and universities to the faculties of which university graduates were appointed this year are: Cornell, the University of Pennsylvania, University of Chicago, Amherst, Dartmouth, Stanford University, the University of California, Northwestern University, the state universities of Michigan, Georgia, Nebraska, Utah, Illinois, Idaho, Indiana, South Carolina, Oregon, Iowa, Kentucky, Minnesota, Kansas, Washington, Tennessee and Missouri, and the state agricultural colleges of Massachusetts, Georgia, Kansas, Oregon, Minnesota, Michigan, Missouri and Iowa.

It is understood that Dr. James R. Angell, professor of psychology in the University of Chicago, has declined the presidency of Dartmouth College.

Henry Asbury Christian, A.B. (Randolph-Macon '95), M.D. (Johns Hopkins '00), Hersey professor of the theory and practise of physic at Harvard University, has been appointed dean of the medical school.

Professor Francis E. Lloyd will fill the chair of botany in the Alabama Polytechnic Institute after November first. During the past year he has been engaged with the Continental Mexican Rubber Company in the investigation of possible methods for the growth of the Mexican desert rubber plant, *Parthenium argentatum* A. Gray, under conditions of cultivation.

At Cornell College, Iowa, Mr. Layton Gouldin has been appointed assistant in chemistry, C. W. Lounsberry in engineering, and E. K. Mapes, in physics.

At Bryn Mawr College Mr. Chester A. Reeds who, until recently, has held a position

in the department of geology at Cincinnati University, has been appointed lecturer in geology to succeed Dr. D. W. Ohern.

At Harvard University, Paul Hayhurst, A.B., has been appointed instructor in economic entomology.

The following appointments have been made in the College of Applied Science, the State University of Iowa: Mr. Sherman Melville Woodward, M.S., Washington University, 1893, M.A., Harvard, 1896, joint author with Mr. Charles E. Lucke of "Tests of Internal-Combustion Engines on Alcohol Fuel," and in collaboration with Mr. John Preston, translator of E. Sorrel's "Carbureting and Combustion in Alcohol Engines," has been made professor of hydraulics and engineering materials, and acting head of the department of mechanical engineering. Professor Woodward at the time of his appointment was supervising engineer in the United States Department of Agriculture. Mr. Arthur Warren Hixson, A.B. (Kansas, 1907), has been appointed instructor in mining and metallurgy, in charge of the department of mining; Mr. John E. Boynton, B.S., M.E. (Wisconsin, 1905), instructor in steam engineering; Mr. John Hoffman Dunlap, A.B. (Dartmouth, 1905), C.E. (Thayer School of Civil Engineering, 1908), instructor in descriptive geometry and drawing; Mr. Wallace Woodman Smith, B.S., C.E. (Pennsylvania State College, 1908), instructor in descriptive geometry and drawing; Mr. George John Keller, instructor in shopwork.

Austin teaching fellows at Harvard University have been appointed as follows: Ralph Ernest Chase, A.M., history; John Detlefsen, A.B., zoology; Warren MacPherson, S.B., A.M., comparative pathology; Frank Linden Richardson, M.D., surgery. Newly-appointed assistants include: Edward Allen Boyden, zoology; Eugene James Cardarelli, chemistry; Edward James Curran, M.D., anatomy; Richard Dexter, A.B., M.D., clinical medicine; Gustavus John Esselen, Jr., Augustus Henry Fisk, A.M., Gorham Waller Harris, A.B., and William Hammett Hunter, A.M., chemistry.

DISCUSSION AND CORRESPONDENCE

THE PROCEEDINGS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS

To the Editor of Science: The *Proceedings* of the Association of Official Agricultural Chemists for 1907 have just been published as bulletin No. 116 of the Bureau of Chemistry, U. S. Department of Agriculture. By order of the printing committee of the department, the portion of the *Proceedings* referring to the report of the committee on the president's address, 1906, has been omitted in the bulletin, as was also the president's address itself in the printed *Proceedings* for the preceding year (bulletin No. 105, Bureau of Chemistry, U. S. Department of Agriculture).

It may be stated in explanation of these omissions that the president's address delivered at the annual convention of the association, October, 1906, among other matters, discussed recent publications of the Bureau of Soils of the U. S. Department of Agriculture and took decided issue with views set forth therein. The president's address having been published elsewhere (see below), it would seem only right that members of the association and men of science in general, who are interested in the questions at issue, or in the larger question of the liberty of free speech, shall be given an opportunity to become acquainted with the report of the committee; on behalf of the committee, I would ask, therefore, that the enclosed portion of the proceedings of the association referring to the report, as prepared by the secretary of the association, be printed in Science.

F. W. Woll

University of Wisconsin,
Madison, Wis.

In the absence of Chairman Woll, Mr. Van Slyke presented the report in behalf of the committee on the president's address:

REPORT OF THE COMMITTEE ON PRESIDENT'S ADDRESS (1906)

By resolution of this association at its last convention it became the duty of your committee, "after consultation with the Secretary of Agri-

culture, to consider in detail the questions raised" in the president's address.[1] These duties your committee has performed and now desires to present the following report and be discharged.

The character of the work assigned us is new and without precedent. The essential facts appear to be that the president of this association, in his inaugural address, speaking on the duty of science to agriculture in guarding against error as well as in discovering truth, expressed views antagonistic to those published by one of the bureaus of the Department of Agriculture and criticized adversely certain of its published doctrines, designating the publications specifically and the bureau by name. These being the facts, as your committee understands them, there seem to be three pertinent questions to be considered:

First, Is it proper for an officer of this association to criticize the published work or doctrines of an institution or of individuals?

Second, Is the association responsible therefor?

Third, Did the president correctly state and construe the facts, observations or statements upon which he based his criticisms?

As to the first question, your committee is of the opinion that liberty of criticism of this sort is entirely proper and, more than this, is necessary to the existence of a scientific deliberate body. Free discussion, such as obtains the world over among scientific men, spoken in convention and printed in journals, is indispensable to progress. To suppress what one conceives to be the truth, because it does not accord with the views of colleagues, is an enormity hardly conceivable to liberal-minded men. This principle, once admitted to govern our proceedings, would put an end to the association's usefulness.

As to the second question, it is the sense of your committee that the association is not in any degree responsible for the views expressed by its members in debate or public addresses. That, beyond enforcing ordinary parliamentary laws and courtesy, the association does not and should not exercise censorship over debate or other discussion. Views expressed by members are to be understood as their personal opinions. The association is responsible only for that which it has authorized by formal vote.

In attempting to answer the third question we have carefully verified the figures and statements quoted in the address, by comparison with the publications from which they were derived and by correspondence with the persons familiar with the investigations under discussion. We find them accurately stated and properly used in a legitimate scientific discussion of matters of the greatest interest and importance to agricultural chemists. In our opinion, the facts as stated in the president's address are essentially correct.

As supplementary to this report, your committee submits as exhibits to be filed the following documents bearing upon its work and leading to its conclusion:

A. Letter from Chairman Woll to the Secretary of Agriculture.

B. Answer to same from the Secretary, January 19, 1907.

C. Letter of March 25 from the secretary transmitting Circular 22.

D. Circular 22 from the office of the Secretary of Agriculture.

E. Statement of Dr. Hopkins in regard to Circular 22.

F. Letter from Director Thorne explaining his position.

G. Circular 70 of the Ohio Station relative to Circular 22.

H. Circular 105 of the Illinois Station, being the president's address, as published in pursuance of the resolutions of the association.

I. Bulletin 167 of the Ohio Station.

J. Farmer's Bulletin No. 257 of the Department of Agriculture.

K. A detailed discussion of the issues involved under question No. 3 above, prepared by Chairman Woll with the assistance of some other members of the committee.

(Signed)

L. L. Van Slyke,	B. B. Ross,
Jacob G. Lipman,	F. W. Woll,[2]
R. J. Davidson,	A. M. Peter.[2]

Mr. Lipman spoke at some length concerning the necessity of the association fulfilling its duty both to the farmer and to the scientific world in taking no equivocal position in regard to the methods of scientific research,

[1] President Hopkins's address on the duty of chemistry to agriculture, 1906, was published as Circular 105 of the Illinois Station.

[2] The signature of the absent chairman of the committee, F. W. Woll, and that of A. M. Peter were appended subsequent to the meeting, the report having been submitted to them. The other absent member of the committee, Mr. C. L. Penny, signified his agreement to the report in the main, but took exception to one phase of it, and his name, therefore, does not appear.

approving only such as maintain the highest plane of intellectual integrity and conservatism in the deduction of conclusions from the facts.

President Hopkins is in no need of vindication by a committee of this association. The facts in the case speak for themselves and every chemist and student of soils whose opinion is at all worthy of respect will amply sustain him in the interpretation of these facts. The unanimous action of the committee was inspired, above all else, by the desire to discharge a duty to those who rely on the association as an authority as to strictly scientific methods of research, and the practical application of the results of such work to agriculture. The members of the association are not only affiliated with control and research work, but frequently serve also as teachers in our agricultural schools. They should not, therefore, shirk the moral responsibility imposed upon them. A negative attitude could not be assumed in the discussion under consideration, nor could it be honestly ignored.

The report of the committee was adopted by the association.

APPOINTMENTS IN COLLEGES AND UNIVERSITIES

To the Editor of Science: The question raised by Professor Wenley in Science, August 21, as regards the desirability that each great department of inquiry should establish a "bureau of information to bring men and places together," appears to me to relate to a need which deserves the ventilation suggested by Professor Wenley, with a view to common action. Probably no department feels this need more than that of mathematics in view of the fact that so few people are familiar with the real nature of advanced work in mathematics, or, in the more emphatic words of Sir Oliver Lodge, that "the mathematical ignorance of the average educated person has always been complete and shameless." This fact has too frequently led authorities to accept men at their own avowed estimate, or at the estimate of some friends who did not take the matter very seriously, since they were not held responsible for their advice by the men who really understood the situation.

While publications like "American Men of Science" render valuable assistance, yet this service is far from complete in view of the facts that the grouping in such a work cannot be sufficiently minute, nor can the issues, with up-to-date changes, be sufficiently frequent to afford just the information that is generally needed by those entrusted with the filling of important positions. In considering this question the Carnegie Foundation for the Advancement of Teaching in its Bulletin Number Two, issued May, 1908, calls attention to the method adopted in the choosing of professors in the Italian universities, which has shown excellent results. The main feature of this method is that the professor is finally chosen by a jury of five professors of the same subject or of a kindred subject to that in which the vacancy exists. In the selection of this jury the faculty of each of the twenty-one Italian universities is invited to vote for five men, and the minister of public instruction chooses five names from amongst the ten having the highest votes.

In sharp contrast to this method stands the inbreeding system followed by most of the larger American institutions, and the still more vicious system adopted by many of the smaller institutions as well as by some of the larger ones, according to which the vacancy is made known to only a few trusted individuals in order to avoid the examination of the credentials of a large number of applicants. One of the principal objections to the system of inbreeding is that it does not emphasize sufficiently high scholarly attainments and tends to encourage superficiality, which frequently attracts local attention, but seldom receives national recognition. It is said that chiefs of divisions under the federal government are frequently surprised at finding, by means of the civil service, men of very high ability who had been hitherto entirely unknown outside of their own regions. Such discoveries would be of the greatest importance to the college and the university,

and a system of appointments is necessarily defective in so far as it does not insure the finding of the very best available man for the vacant position.

While a system of appointments calling for a national survey by specialists whenever an important position is to be filled would doubtless serve as a great incentive to the younger men, yet the main advantage would result from the fact that men of the greatest energy and ability would be placed in positions where they could work to the best advantage, instead of wasting the greater part of their energies while others are wasting most of their opportunities. It is a question calling for national action, since our system of inbreeding is so well intrenched and works to the advantage of so many persons of mediocre ability, that it is scarcely to be expected that the authorities would be willing to face the storm resulting from a decided change in a single institution.

The natural body to establish a bureau of information, if Professor Wenley's suggestion were to be adopted, would appear to be a national organization of men representing the department of inquiry. If the American Mathematical Society and the American Chemical Society, for instance, would appoint committees representing the various parts of the country, and entrust such committees with the nomination of the best possible men for the positions brought to their attention, they would doubtless render a most important service. As such a committee would feel the great responsibility of having their actions reviewed by a national society of experts, it would doubtless look into the matter much more carefully than individuals do, who are casually asked to express their opinions in regard to the best available men. It seems also likely that appointing bodies would generally be very eager to secure such expert advice and thus remove a part of the responsibility from their own shoulders.

Whether such a bureau of information would be as satisfactory as the Italian system, properly modified to meet our situation, it seems difficult to predict. At any rate, the present haphazard method seems so bad that it does not appear likely that any one resulting from a full discussion of the matter could fail to be far superior. It need scarcely be added that a wise system of appointments would be apt to check the tendency towards czarism on the part of our big institutions—a tendency which has alarmed many of our best men and threatens to serve as a barrier in securing the very best talent for university positions.

G. A. Miller
University of Illinois

ON THE ORIGIN AND AGE OF THE SEDIMENTARY ROCKS

To the Editor of Science: In replying to Dr. Barrell's criticisms[1] I wish, first of all, to make it clear that I have no fault to find with the "detailed studies of the geological record"; the matter in dispute has to do with the *theories* which the geologists have founded on their interpretations of the observations.

Dr. Barrell states that I claim to have demonstrated that the earth was "protected by a cloud envelope until the Tertiary"; herein he disregards my published—qualified—statement that (in view of my results) Manson's hypothesis must now be modified; and the nature of this modification is clearly indicated by my references to "warmer" and "colder" months of the year as still existing at the very beginning of a glacial epoch; in other words, while I accept the theory that the former higher temperature of the ocean was necessary to supply the material for the (now disappearing) ice sheets, I find that climate then, as now, must still have been local, and there seem to be no good reasons why climate should not have been sensibly local in those earlier times for which we have records showing that living organisms then existed; only in the still earlier history of the earth was the cloud mantle so thick that the sun's influence was rendered practically insensible at the earth's surface.

But, considering the comparatively small size of the earth, this condition of things could exist through the hundreds of millions of

[1] Science, pp. 371–3.

years (which geologists claim were required for the formation of the rock layers containing evidences of former terrestrial life) only on the supposition that there was practically no radiation into space of inherent earth-heat; the assumption has been that the earth's surface temperature was kept from falling to a lower temperature because of the assumed high temperature of space (by "temperature of space" I mean the temperature of the solar rays in free space at the earth's distance from the sun).

But, as I have demonstrated that the temperature of space is far below the hitherto accepted value of this constant, the earth must be losing its heat with much greater rapidity than the advocates of a cooling earth have, theoretically, found to be the case for the data used. If, as most geologists claim, the stratified rocks were produced by a rearrangement of the matter previously contained in the older rocks, then, indeed, the hundreds of millions of years might easily be required to produce the rock strata built up since pre-Cambrian times; but, if the building material was obtained and transported in the manner here explained, the geological periods were of very much shorter duration.

To make a fairly comprehensive reply to Dr. Barrell's criticisms a very brief presentation of my theory as to the origin of the main sedimentary rocks will be necessary.

I find that geologists in their studies have regarded as unessential the part which the ancient volcanoes must have played in the formation of rock strata. Without in any way calling in question certain assigned effects produced by the action of water in its various forms and positions, it seems to me that the transporting power of the atmosphere must have been by far the most efficient agent for covering the earth's surface with different layers made up of finely divided matter which was originally ejected into the atmosphere in the form of volcanic dust, the chemical constitution of which varied from time to time and was further modified by contact with the atmosphere and water.

In a recent issue of Science I show, theoretically, that the eastward circulation of our atmosphere is caused by a vertical circulation (the ascending matter being arranged in the form of an expanding spiral having the greatest density near the axis of the spiral), resulting from ruptures of air strata in unstable equilibrium because of the different temperatures due to trapped heat. Now it is known that the gases issuing from certain volcanic vents are not only under very great pressure, but the temperature of these gases is very high, consequently the lighter materials also issuing from the vent will be carried to various great heights along with the expanding gases, and before these materials have time to settle back to the earth's surface differential angular drifts (diurnal) cause this matter to be distributed throughout a broad zone parallel to the equator and completely encircling the earth. Owing to the eastward circulation of the atmosphere, much more matter falls on the east side of the meridian of the vent than on the west side, as the heavier materials settle back to the earth sooner than the lighter ones. In general, therefore, the slope of the accumulated material will be long and gradual on the east side, but short and steep on the west side of a volcanic region. If the surface on which the débris falls is the ocean (or other body of water), most of the matter finally sinks to the bottom and forms stratified layers; but if water currents are present, a different distribution is made.[2] Wind and rain tend to keep the higher land areas swept clear of such matter, so that stratified layers do not, as a rule, accumulate on such a surface.

[2] As the weight of the deposit is much greater on the east side, the weak, severely strained crust on the west is often found dipping into the ocean; and local débris-transporting currents are formed by contact of the water with both the thin crust of the earth and with the heated matter forced into the bed of the ocean through newly-made faults or fractures. The greatest crustal heat is conveyed to the water at the greatest ocean depths; from this it follows that the greatest ocean currents should be formed among the volcanic islands.

According to this theory, then, in pre-Archean times when the crust of the earth had fallen to the temperature at which water would no longer boil, the water-vapor in the atmosphere began to condense to form the primitive ocean; tidal effects produced irregular distribution of crustal tension, causing fractures (most probably along meridian lines), of the solidified crust, thus allowing the seepage of surface-water and the consequent formation of the first volcanic vents. As a result of the constantly increasing weight of a given cone, the supporting crust in the immediate vicinity was depressed deeper and deeper below the general level (and still farther depressed through the additional weight of the now water-filled surrounding valley), causing a series of circular wave-like upthrusts separated by water-filled valleys of decreasing depths as the distance from the vent increased. The linear series of vents, along the line of fracture, through continuous growth finally formed a central serrated ridge bounded on each side by a series of parallel ridges of decreasing height. The eastward motion of the atmosphere caused the valleys on the east side to be filled much more rapidly than those on the west side, and thus produced the conditions favorable for the formation of a continental surface sloping to the east, from the volcanic ridge.[3]

About Archean times the decreased surface temperature—the changed topography of the rock surface (due to the unequal distribution of the volcanic débris, thus causing differential uplifts), and the consequent partial removal of the cloud envelope in certain regions—made possible the advent of other forms of matter, including living organisms.

As the thickness of the crust continued to increase—mostly through the addition of materials from the earth's interior—the number of the then existing vents gradually decreased, through the closing of the seepage channels by the volcanic débris. Later on, fresh fractures along neighboring lines of least surface strength resulted in the formation of new vents, and a new era of a dust-filled atmosphere, with its accompanying consequences, was again inaugurated.

As nearly all the material forming the layers deposited on the primitive crust was taken from the interior of the earth,[4] the accumulated warping of the crust towards the close of the period during which the sedimentary rocks were formed was very great —*much greater than could have resulted from shrinkage due to radiation of heat from the inside-out surface alone!*

If the erupted material for a given rock layer was laid down slowly, through long-continued activity, the evidences of former terrestrial life may be visible throughout the whole thickness of the rock formed; but if the deposition of matter was very rapid, all signs of former life may be wanting, and the total extinction of certain organisms may thus have resulted.

Some of these layers may have been deposited in the course of a few years, or even days, while for the formation of others, centuries may have been required.

With the removal of the lighter constituents of the earth's interior to the exterior surface, and the consequent strengthening of the crust, the number of active volcanoes rapidly diminished, thus practically closing the active period of sedimentary rock formation, leaving, in the main, only the ever-present secondary effects, resulting from surface erosion, to continue in operation.

By far the greatest result of these secondary causes is the topographic change produced by the two ice sheets of recent origin; these ice sheets, now mostly confined to the two arctic regions of the earth, but which only a few

[3] On the area between neighboring fractures extending in an east-west direction more débris was, of course, deposited—forming high table-lands—and the eastward extension of the slope became greater than was the case for fractures extending in a north-south direction. Long-continued local deviation from an eastward motion of the atmosphere caused a corresponding change in the direction of the local slope.

[4] During the past eighteen years I have published a number of short papers which favor the theory that the earth's surface is also continually receiving finely divided matter which has been ejected from the sun.

thousand years ago extended, in certain directions, well into the temperate zones, seem to offer positive evidence that the earth is growing colder. The theoretical (beautifully simple) explanation of the origin, growth and final retreat of the ice, which results from my modification of Manson's hypothesis, is, very briefly stated, as follows:

After the minimum polar-surface-temperature had fallen to 0° C. snow commenced to fall at the two poles during the respective winter months; each year this snow was, for some time, completely melted during the respective warmer seasons of the year; as the earth grew colder, the snow and ice covering became permanent and spread equatorwards with seasonal fluctuations at the ice front; but as the ocean grew colder the amount of evaporation from its surface decreased, so that the available amount of snow to be melted at the ice front continually diminished (while the intensity of the direct solar rays at the surface of the earth was, for a given latitude, continually on the increase);[5] a final retreat of the ice front was, therefore, inevitable. As the snowfall will later on cease altogether, the land ice will continue to retreat and probably disappear at the poles. These results are for ideal sea-level conditions; topographic irregularities, differences of elevation, direction of air and water currents—all act to produce great deviations from the theoretical results here made to depend on latitude and ocean temperature alone; these deviations have, in the past, been so great that evidences of former *local* glaciation should be found throughout nearly the whole series of stratified rocks.

In addition to the theoretical data given on page 415 of the current volume of Science, I would, in connection with Dr. Barrell's remarks on radiation of heat, call special attention to the fact that, since the publication of my paper demonstrating that Newton's law of radiation is theoretically exact, no less authority than Professor Newcomb has asserted (but not demonstrated) that Stefan's law of radiation has been established; now, as I claim to have demonstrated that "some surprising error in previous methods" has actually developed, Dr. Barrell or some other scientist must show that my demonstrations are erroneous before further intelligent use can be made of laws of radiation established by others and used (to quote from Science, February 14, 1908, p. 269) as "the formulæ accepted to-day" by scientists.

J. M. Schaeberle

Ann Arbor, Mich.,
September 29, 1908

[5] Because of this condition of things, it seems extremely probable that formerly, when the arctic climates were less severe, equatorial and temperate regions were for a time actually somewhat colder than they are to-day, for the lowering of the surface temperature resulting from the ever decreasing heat-trapping power of the atmosphere was, for a time, probably more than offset by the increased intensity of the direct solar rays.

CLOUDS OVER A FIRE

To the Editor of Science: In connection with Mr. B. M. Varney's letter on "Clouds over a Fire" in Science for May 15, 1908, I may say that I have often observed the same phenomenon here. In cutting sugar cane the stalks are stripped of leaves in the field, and when the cutting of a field is finished the leaves are set afire as they lie spread over the field. When the weather is calm there arises a column of dark smoke which is often beautifully capped by a mass of white cloud. I have wondered whether the particles of smoke furnish nuclei for the formation of water drops as the smoke rises to a level of supersaturated air, or whether, as Mr. Varney suggests, the draft carries water vapor to a level of cloud formation.

Wm. F. Wallis

Ewa, Hawaii

QUOTATIONS

DANIEL COIT GILMAN

Dr. Gilman was soon called from California to conduct what was, at its inception, a unique undertaking. This was nothing less than the establishment of a university for graduate study, with an equipment and faculty that should make it the rival of the best universities of Europe. On the disap-

pointments and even failures of this enterprise we need not dwell. At one period the Johns Hopkins suffered heavy financial losses, and its resources have always fallen far short of its ideals. But hampered as the university has been by lack of money, of equipment, and of men, it has yet been one of the most potent forces in elevating the intellectual standards of our colleges. The young men who gathered at the Johns Hopkins in the early days under Gildersleeve, Rowland, Remsen, and Sylvester were filled with enthusiasm for exact and extensive learning. There is always, we grant, the danger that vast erudition will not become assimilated and humanized; that it will remain mere pedantry. This peril the graduates of Johns Hopkins incurred; and some of them did not wholly escape it. But in the seventies and eighties our education was less Germanized than now and in an era of slipshod training, Johns Hopkins offered the kind of severe drill that was sorely needed. The graduates carried the gospel of a rigorous scholarship from one end of the country to the other, and made it more and more necessary for teachers, both in college and school, to be masters of their subject. This was perhaps Dr. Gilman's greatest contribution to the cause of education in America. How great it is we can not yet estimate; for the men whom he and his faculty prepared for teaching are yet with us, distinguished in their various callings, and we can not view their labors in proper perspective.

It was Dr. Gilman's fortunate lot also to guide the Carnegie Institution of Washington in its first three years. The conception of foundations for scientific research had made very slight headway in this country. We have had a few laboratories that are endowed, and here and there a university has been willing to maintain a professor—say, in astronomy—who is not expected to teach, but who can devote his energies to extending the limits of our knowledge. But the notion of research, without prospect of return in cash dividends, has not appealed to a utilitarian people. More than that, few colleges, under the pressure of undergraduates demanding instruction, have been able to set aside funds that did not seem immediately productive. The Carnegie Institution, then, like the Johns Hopkins, was established at a moment of need. We can not doubt that in the long run it will do as much, perhaps even more, to raise the standards and the tone of scholarship in America. It was fortunate in receiving its first shaping from the hands of a man of Mr. Gilman's long experience and wide views.—New York *Evening Post*.

SCIENTIFIC BOOKS

The Harvey Lectures. Delivered under the Auspices of The Harvey Society of New York, 1906–7, by Professors A. E. Wright, C. A. Herter, W. T. Porter, J. G. Adami, F. G. Benedict, E. B. Wilson, George S. Huntington, W. T. Councilman, Friedrich Müller and Dr. S. J. Meltzer. Pp. 1–314. Philadelphia and London, J. B. Lippincott Company. 1908.

The appearance of this volume marks the completion of the second year of the Harvey Society. Starting more or less as an experiment based on the assumption that there was a desire on the part of practitioners of medicine to acquire at first hand from men engaged in research more knowledge concerning the scientific problems and principles underlying their profession, the Harvey Society has made for itself a permanent place as a factor in higher medical education. Its usefulness is no longer a matter of doubt, but is now an assured fact. Nor is its sphere a local one, since through the publication of its lectures, these are brought within reach of all.

This paragraph from the preface of the present volume states concisely the position of the Harvey Society. The society was organized in 1905 for the purpose of bringing before medical practitioners the results of important scientific investigation in medical and allied fields. It has a membership of one hundred and seventy-five investigators or practitioners of New York City, and has now held three courses of lectures. Those of the first course were published in 1906, those of the third course are soon to appear, and the present volume includes the ten lectures of the second course. Foreign men of science are represented by two men of distinction: Sir

Almroth E. Wright, of London, whose work on the opsonic index has opened a new field of many possibilities, discusses the principles of vaccine therapy, especially under the guidance of the opsonic index; while Professor Müller, the eminent clinician of Munich, reviews the nervous affections of the heart, from the standpoint of one who is familiar with modern cardiac physiology and pathology. Professor Herter, of Columbia, discusses the common bacterial infections of the digestive tract and the intoxications arising from them—a subject which his researches have made largely his own. Professor Porter, of Harvard, discusses vasomotor relations in animals and men, partly with reference to the theory of vasomotor depression in shock, and presents many results of his own experiments. Professor Adami, of McGill, deals with the myelins and potential fluid crystalline bodies of the organism, showing their wide distribution and their physical and chemical relations. Dr. Meltzer, of the Rockefeller Institute, under the title "The factors of safety in animal structure and animal economy," raises the question whether in the structures and functions of the animal organism considerations of economy or of luxury, the latter involving the factor of safety, are paramount, and demonstrates the wide occurrence of safety mechanisms. Professor Benedict, the director of the Nutrition Laboratory of the Carnegie Institution, presents the results of a long series of observations on the metabolism of human beings during inanition, the work having been done with the aid of the large respiration calorimeter at Wesleyan University. Professor Wilson, of Columbia, summarizes the results of some recent studies of heredity, especially certain researches on the chromosomes, which may prove to furnish a physical explanation of the main facts of Mendelian heredity. Professor Huntington, of Columbia, presents the standpoint of the modern anatomist in an article, accompanied by many illustrations from his own preparations, on "The genetic interpretation and surgical significance of some variations of the genito-urinary tract." Professor Councilman, of Harvard, describes the changes in the lymphoid tissue in certain of the infectious diseases, particularly in diphtheria, scarlet fever and small-pox.

Each lecture represents a valuable summary of present knowledge in its specific field. Furthermore, the lack and uncertainties of present knowledge are often indicated, and the possibilities of investigation along specific lines are emphasized. It is in the element of stimulating suggestiveness that the value and charm of the book largely lie. Each author writes as a master in his own subject, and the reader can not fail to feel this. The whole volume reflects the spirit of the modern scientific method, of which each author is an able exponent.

The Harvey Society has already received wide attention and approbation outside the immediate circle of its auditors. With its annual output from the leaders in the medical sciences it is doing a most important work in bridging the gap, which ought never to exist unbridged, between the laboratory investigator and the medical practitioner. Its annual volume of lectures can not fail to find a wide circle of readers.

Frederic S. Lee

Columbia University

Pollution of New York Harbor as a Menace to Health by the Dissemination of Intestinal Diseases through the Agency of the Common House Fly. A report by Daniel D. Jackson, S.B., to the Committee on Pollution of the Merchants' Association of New York. The Merchants' Association of New York, New York City, N. Y., July, 1908. 22 pp.; maps Nos. 1 and 2, 3 diagrams, 2 plates, 1 table.

This attractive little report of an investigation of the sanitary conditions of the water-front of New York City made during the breeding season of 1907 deserves attention, especially from the sanitarian and the medical profession if not from the general biologist and the laity.

The investigation consisted of an inspection of the entire water-front of the city in order to show the presence of numerous sources of infection and breeding places for

flies, and secondly, of a study of the abundance of flies and their connection with the spread of intestinal diseases of man, and what proportion of these diseases were due to the agency of the common house fly.

The investigation was carried on primarily to obtain evidence for the Committee on Pollution of the Merchants' Association of New York, that unsanitary conditions existed and that these conditions were directly responsible for the prevalence of certain intestinal diseases of man; so that the said committee would have some basis for complaint to the proper authority against the open violation of the health laws by the citizens of the city. The inspection of the water-front (pp. 8–16) revealed large quantities of both human and horse excreta exposed to fly infestation on piers, along the beach, and so forth, as well as sewage and refuse matter of all kinds; in a word an abundance of decomposed matter and filth suitable for the breeding place of flies, and swarming with the latter and their young.

Having obtained evidence by means of inspection that the forementioned unsanitary conditions existed, and that flies were breeding in and frequenting the fecal matter exposed to them, an investigation was also conducted by means of fly traps placed in various parts of the city, to determine what bearing the products (flies) of these conditions had upon the actual transmission of intestinal diseases within the city.

The traps near unsanitary points caught the largest number of flies, showing that these conditions attracted them; those in cleaner portions of the city caught but very few. The flies caught in the traps were counted each day and tabulated by weeks. The weekly totals are then compared by means of a table (p. 17) with the weekly totals of deaths in the city from diarrhoeal diseases, showing parallelism; this is further brought out by means of two diagrams (facing p. 14) showing the coincidence of the maximum abundance of flies and of that of the intestinal diseases of man. Still another diagram (facing p. 12) gives the curves of temperatures, representing fly activity, and of typhoid fever and other intestinal diseases, for a period of the five preceding years, again showing almost exact parallelism. Two maps (maps Nos. 1 and 2) are also introduced as further evidence, showing the location of the individual cases of typhoid fever in the Borough of Manhattan (map number 1) for 1904, and the location of deaths from intestinal diseases for the same area during 1906 (map number 2), and they emphasize the fact that the great majority of the cases of sickness and of death were located at those points found to be most unsanitary in 1907; that is to say, were distributed over the fly-breeding area. A few other minor corroborative facts are recorded, such as the finding of numerous pathogenic bacteria on the appendages of flies during the breeding season, and but little or none at all on them just following hibernation. The conclusion indicated is obvious, but I quote the author's concluding paragraph (p. 19):

> It is to be hoped that the gross defects which we have pointed out in general sanitation as well as in sewage disposal will be remedied before the summer of 1908. We have estimated that proper sanitation along the lines pointed out will reduce the typhoid deaths in New York from 650 to 360 a year and the diarrhœal deaths from 7,000 to 2,000 a year. This latter figure provides that germ-infected flies are not permitted to contaminate the milk supply before it reaches the city or after. This saving of over 5,000 lives a year will also be accompanied by the additional saving of some 50,000 cases of sickness.

While the report establishes no new facts in regard to the transmission of diseases by flies (*Musca domestica* Linnæus), it is an important *exposé* of actual conditions existing in our most crowded city, and is corroborative of previous investigations; besides, it brings out the possibilities of lessening deaths and sickness due to the agency of house flies by proper sanitary measures.

As a contribution to science, the report is very poorly presented; it suffers especially from lack of arrangement and will give trouble to the bibliographer. No new biological facts are recorded about the common house fly, and the author apparently does not

distinguish between this species (*Musca domestica* Linnæus) and others, which under certain conditions may have appeared in the traps in considerable numbers, and while having no relevancy, materially affect the results. Such biological facts as are given are compiled without reference to sources, and some of the statements are obviously wrong. For instance, this—"The number of eggs laid by each female fly during the season is about 1,000" (p. 17). Presenting compiled matter in this manner can not be too strongly discouraged, as it forms a stumbling block to future investigators; for appearing to have originated with the author giving them and based on sufficient data, in reality they are statements made by others and should not be accepted unless the sources are given. Otherwise, science would be credulous.

A. ARSÈNE GIRAULT

URBANA, ILL.,
September 23, 1908

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for September begins with an article by T. D. A. Cockerell on "Some Results of the Florissant Expedition of 1908." It notes that the best exhibit of Florissant fossils is now at the University of Colorado and incidentally describes two new species of fossil plants. Leroy D. Swingle describes the "Embryology of *Myosurus Minimus*" and this arouses the query should a specific name be capitalized even in the title of an article? J. A. Allen presents "Another Aspect of the Species Question" showing that the problems of nomenclature are somewhat different in zoology from what they are in botany and that botanists do not always describe their species so that they may be recognized from the descriptions alone. G. H. Parker considers "The Origin of Vertebrate Eyes" casting the weight of his opinion with those who consider that they arose from the internal central nervous system and not on the exterior.

Bird-Lore for September-October contains the following articles, mostly illustrated: "A Raven's Nest," by Francis H. Allen, "Hummingbird Eccentricities," by Mary P. Allen; "A Mockingbird's June," by Albert V. Goodpasture; "The Growth of Young Black-billed Cuckoos," by A. A. Saunders; "Chestnut-sided Warbler," by Mary A. Dickerson, and the sixth paper on "The Migration of Flycatchers," by W. W. Cooke. The "Educational Leaflet," by Mabel Osgood Wright, is devoted to the kinglets. The report of the Audubon Societies notes the establishment of three new Bird Reservations, near Kev West, Fla., Klamath Lake, Oregon, and Lake Malheur, Oregon.

The Museums Journal, of Great Britain, for August contains a brief summary of the proceedings at the Ipswich conference, the program followed and lists of officers and members. The papers presented will appear in subsequent numbers. A brief article is devoted to "The British Museum (Natural History)," dealing with the question of the appointment of a keeper of zoology and a director, positions which have been vacant since the retirement of Sir E. Ray Lankester at the end of 1907.

The American Museum Journal for October under the caption "To the Bahamas for Coral" notices the successful expedition made for this purpose and gives some fine pictures of living corals. Additions are noted to the exhibition series of fossil horses and dinosaurs, to the collection of whales, series of heads of game animals, and the exhibit illustrating the motions of the planets.

The Museum News of the Brooklyn Institute notes important changes in the arrangement of the collections and numerous additions to the exhibition series. A novelty is the installation of a large group showing the home of the guacharo bird, so arranged that the visitor can illuminate the cave by pressing a button. Another important group is that of Steller's Sea Lion. An article on the botanical collections calls attention to some important material in the herbarium. The part devoted to the Children's Museum contains a list of material that may be loaned to schools.

THE LOCO-WEED DISEASE

For several decades the loco-weed disease has been a subject of much interest both practical and theoretical—practical because it is the cause of extensive losses of live stock in the western half of the United States, theoretical because to the pharmacologist it has offered an unusually puzzling and tantalizing problem which has hitherto baffled all attempts at solution.

By far the most important contribution ever made to the subject has recently appeared as a bulletin of the Bureau of Plant Industry, United States Department of Agriculture, by A. C. Crawford.[1] In order to appreciate the significance of this piece of work, which is one of the most important contributions to pharmacology ever made in this country, it is necessary to recall the state of knowledge concerning "loco" when Crawford began his investigations. The condition has been known for at least sixty years; the United States Department of Agriculture began to investigate it in 1873 and has returned to the problem at frequent intervals since. In addition it has been the subject of study by a number of state institutions and by many private individuals. The condition has usually been ascribed to the eating of certain plants; most commonly various species of *Aragallus* and *Astragalus* were held responsible for it. All efforts to obtain a poisonous substance from these plants had, however, failed. Most experimentors had been unable to produce any poisonous effects whatever, when the plants or their extracts were administered to animals; Professor Sayre stated that he had sent thousands of pounds of the dried plants to various investigators in America and Europe, but all reports were negative as to pharmacological activity. The condition was ascribed by some to the mechanical action of fine hairs on the plant, by others to bacteria associated with the plants; others denied any causal relation between the plant and the condition and attributed the latter to malnutrition, helminthiasis, etc. The few who had seen poisonous effects from the plants seemed inclined to the belief that a poisonous substance was actually present, but that it was too unstable to admit of isolation except under the most favorable conditions of work.

Thus when Crawford began his work in 1905 it was still a matter of controversy whether the plants he was to study were poisonous or not. Field experiments carried out independently by C. D. Marsh and laboratory experiments by Crawford soon showed definitely that it is possible to produce sickness and death by the administration of certain of the plants. The first step having been thus taken, Crawford attacked the problem of the nature of the poisonous substance. Seldom has a pharmacologist been confronted with a more difficult problem; the few clues from the work of the last twenty-five years proved absolutely misleading. It is impossible to give the details, but a brief outline will indicate what an amount of the most painstaking work was necessary before success was finally achieved. Having determined the amount of plant necessary to kill a rabbit of a certain weight, Crawford proceeded to the chemical examination controlling each step by experiments on animals. One group of poisons after another—volatile poisons, alkaloids, glucosides, organic acids, toxalbumins—were excluded. The first encouragement came when it was found that the toxicity was not destroyed by boiling. This was followed by the surprising discovery that the ash of the plant was poisonous; if any conclusion was to be drawn from the work of previous writers it was that the poisonous substance—if such were present at all—was so unstable that it did not withstand even drying!

After the discovery that the ash was toxic there were still many difficulties. The ash was very complex but Crawford systematically separated it into many fractions, testing each physiologically. In this way all of the common heavy metals were excluded; the ash however, contained small amounts of zirconium, titanium, etc. All of these as well as beryllium, thorium, thallium, had to be

[1] "Barium, A Cause of the Loco-weed Disease," Bull. 129, Bureau of Plant Industry.

excluded by various chemical and physiological tests. Search was also made for a radio-active substance. Chemists had called attention to the abundance of calcium in the ash; this and strontium were excluded from being the toxic agents.

Finally Crawford noticed that extracts prepared with sulphuric acid were inactive; further, that active extracts caused a rise of blood-pressure. Both of these observations suggested the presence of barium. After a long series of careful experiments the author reached the following conclusions:

> A close analogy exists between the clinical symptoms and pathological findings in barium poisoning and those resulting from feeding extracts of certain loco plants. Small doses of barium salts may be administered to rabbits without apparent effect, but suddenly acute symptoms set in analogous to what is reported on the range.

Finally barium was found in the ash of many "loco" plants in amounts sufficient to account for the symptoms.

Among the other important conclusions, some of which help to explain the unsatisfactory results of former workers, are the following:

> Loco plants grown on certain soils are inactive pharmacologically and contain no barium. In drying certain loco plants the barium apparently is rendered insoluble so that it is not extracted by water, but can usually be extracted by digestion with the digestive ferments.
>
> The barium to be harmful must be in such a form as to be dissolved out by digestion.
>
> In deciding whether plants are poisonous it is desirable not merely to test the aqueous or alcoholic extract, but also the extracts obtained by digesting these plants with the ferments which occur in the gastro-intestinal tract.

These experiments afford another illustration of how indispensable are animal experiments in all kinds of pharmacological work.

The author conservatively limits his conclusions to the plants he has studied, and recognized that in the plants grown in other localities the toxic action may be due to substances other than barium.

There is an extraordinarily rich and well-selected bibliography of the entire subject of "loco" and also of barium poisoning in both man and the domestic animals.

It seldom falls to the lot of an investigator to carry to such a successful conclusion a problem of such complexity and so baffling; it will long remain as one of the most notable contributions to pharmacology made here or abroad.

Reid Hunt

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SPECIAL ARTICLES

THE EFFECT OF LESIONS OF THE DORSAL NERVE ROOTS ON THE REFLEX EXCITABILITY OF THE SPINAL CORD (PRELIMINARY NOTE)[1]

In some preliminary experiments Professor Carlson found that lesions of the dorsal nerve roots appear to have the same effect on the cross reflexes of the spinal cord as transsection of the cord itself. That is, in animals in which the reflexes disappear temporarily after transsection of the cord (spinal shock) the cross reflexes are similarly lost temporarily after lesions of the dorsal nerve roots on one side.

The experiments here reported were undertaken at the suggestion of Professor Carlson in order to determine definitely this parallelism in different animals, because of the important bearing of these results on the theories of spinal shock.

Methods of Experiments.—Section of the dorsal nerve roots to one limb: (*a*) After high section of the spinal cord, (*b*) on the intact animal.

In pigeons, cats and dogs after the high section and recovery from shock and anæsthesia (usually one day) the final operation of cutting the dorsal nerve roots was made without anæsthesia.

Results of Experiments.—The effect on the cross reflexes caused by the cutting of the dorsal roots to a limb is as follows: In snapping turtles, loss of cross reflexes for 5–10 minutes; in frogs, loss of cross reflexes for 15–30 minutes; in pigeons, no loss of reflexes;

[1] From the Hull Laboratory of Physiology, University of Chicago.

in cats (young) loss of reflexes for 30–40 minutes; in cats (old) loss of reflexes for 50–70 minutes; in dogs, loss of reflexes for 75–90 minutes.

In the turtle transverse lesion of the cord usually does not abolish the reflexes except momentarily. This is also true for the pigeon. In other words, lesions of the dorsal roots produce the same shock effects on the spinal reflex mechanism of the limb involved as transverse lesion of the cord itself.

The present theories of spinal shock may be summarized under three heads, viz., (*a*) inhibition due to the trauma; (*b*) loss of tonus impulses to the reflex centers; and (*c*) lesions of the reflex arcs themselves.

The last theory is not applicable to these results. Either one or both of the other two may be applicable to the results here reported. That is the shock may be due to the temporary effect of absence of tonus impulses, or to irritation of inhibitory nerves, or to both of these.

The work is being continued with the purpose of determining this point.

Clyde Brooks

A NOTE ON THE OCCURRENCE OF TWO WEST INDIAN FISHES AT BEAUFORT, N. C.

During August, 1907, the writer collected in the harbor of Beaufort, N. C., two fishes which are for the first time reported from this locality. Both forms are of the tropical and subtropical faunas. A small specimen of *Abudeduf saxatilis* Linn., was seined August 10, 1907, at the Fort Macon jetties. Its length is 2.25 inches. The other form is *Ulæma lefroyi* Goode. A number of these were taken in a dipnet at Pivers Island, August 3, 1907. The smallest fish measured 0.40 inch in length, the largest 0.52 inch.

In order to ascertain the identity of these small fish, which had evidently been hatched only a few days prior to their capture, they were placed in an aquarium of running sea water, and there they were successfully reared. During the first week they were fed on copepods and larval crustaceans which were strained from the tow; this food was then changed to grated oyster on which they thrived vigorously. September 2, 1907, the smallest *Ulæma* measured 0.91 inch in length, the largest 1.12 inches; the rate of increase in length averaged 120 per cent. This method of rearing fry was employed this season for *Fundulus majalis*, which were hatched in the laboratory from eggs which had been artificially fertilized. The young *Fundulus* were reared until they had attained a length of 0.75 inch, when an accidental overflow of the aquarium permitted the fish to escape.

On August 21, 1908, on the landward side of one of the large shoals in the harbor, numbers of small specimens of *Ulæma lefroyi* were collected in a small seine of fine mesh.

For the opportunity of making these observations the writer is indebted to the Hon. Geo. M. Bowers, U. S. Commissioner of Fisheries.

Bartgis McGlone

St. John's College,
Annapolis, Md.,
September 1, 1908

CATALYTIC REDUCTION OF FATS AND OILS

About four years ago it was shown by Paal and Amberger[1] that palladium could be obtained in a particularly active colloidal aqueous solution (hydrosol). Subsequently the senior author demonstrated[2] that this liquid, in presence of hydrogen, was capable of causing the catalytic reduction of nitrobenzene. The work has now been extended to include certain other substances,[3] the most generally interesting of which are oleic acid and a number of oils.[4]

The acid, in the form of its potassium salt, is dissolved in water and mixed with a small quantity of the palladium solution; the liquid being then introduced into a gas-burette containing hydrogen, standing over mercury. Absorption of the gas commences immediately and the reaction is completed in a few hours. No heating is required. Oleic acid, under these conditions, is converted almost quantitatively into stearic acid. Castor oil, dis-

[1] *Ber.*, **37**, 124 (1904); **38**, 1398 (1905).

[2] *Ibid.*, **38**, 1406, 2414 (1905); **40**, 2209 (1907).

[3] *Ibid.*, **41**, 2273.

[4] *Ibid.*, **41**, 2282 (1908).

solved in a mixture of ether and alcohol, is transformed into a crystalline fat, which softens at 69° and melts at 77°.

The behavior of olive oil is very peculiar. It combines with three times the quantity of hydrogen which was anticipated from its behavior with iodine. The product, which in general properties resembles that from castor oil, is still capable of combining with iodine. Unless, therefore, some flaw can be shown to exist in the experiments, it will be necessary to revise our ideas of the processes which take place during the ordinary testing of oils and fats with iodine (Hübl's method).

Train oil absorbed about 30 per cent. more hydrogen than was anticipated. The yield of solid fat was quantitative. Before reduction the train and olive oils were converted into emulsions with water and a little gum arabic.

These results promise to be of great importance to plant physiologists, because the reactions proceed under conditions comparable, in a number of respects, with those under which similar or identical products are formed in nature. To the industrial chemist the results may also prove to be of considerable value; a reasonably cheap method of transforming liquid oils into solid fats has been much sought after.

J. Bishop Tingle

McMaster University,
Toronto, Canada,
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SOCIETIES AND ACADEMIES

JOINT MEETING OF GEOLOGISTS OF THE NORTHEASTERN UNITED STATES WITH THE SECTION OF GEOLOGY AND MINERALOGY OF THE NEW YORK ACADEMY OF SCIENCES

The Section of Geology and Mineralogy of the New York Academy of Sciences in cooperation with the geologists of neighboring institutions held an all-day meeting on April 6. The general invitation sent out by the academy met with a generous response. Representatives attended from Massachusetts Institute of Technology, Amherst, Wesleyan, Universities of Vermont and Pennsylvania, Dartmouth, Lehigh, Rutgers, Harvard, Yale, New York University and Columbia in addition to the local membership. Two sessions were held, one in the rooms of the department of geology at Columbia University, the other in the academy quarters at the American Museum of Natural History. Fourteen papers were presented and eight others were read by title. Abstracts of some of these papers are given below:

The Cambrian Rocks of Vermont: G. H. Perkins, State Geologist of Vermont.

So far as satisfactorily determined, the Cambrian of Vermont occupies a narrow strip from north to south through the state between the Green Mountains and Lake Champlain. In some places they reach the shore of that lake and form the boldest of the headlands.

Northward the Cambrian extends to the Gulf of St. Lawrence and south through New York to middle Alabama.

It is probable that there are derivatives from Cambrian strata in and east of the Green Mountains, but none have been certainly identified. So far as studied, all the beds belong to the Olenellus zone of Walcott, or Lower Cambrian. The very interesting and extensive fault and overthrust by which Cambrian strata were lifted and thrown over the Utica is noticed. In all there are not less than 10,000 feet of Cambrian beds in western Vermont. These beds consist of 1,000 feet of more or less silicious limestone, and the other rocks are shales, sandstones, quartzites, conglomerates, of very diverse color composition and texture. In a few places the red sandrock beds change to a thick-bedded brecciated calcareous rock which when worked is the Winooski or Champlain marble—a mottled red and white stone used in many large buildings in many parts of the country.

Few of the beds are fossiliferous, but some abound in trilobites, Olenellus, Ptychoparia, etc., and a few brachiopods, worm burrows, trilobite and other tracks, etc., are also found. In all the number of species is not large, probably not more than fifty have been found. Of these, trilobites form the larger number, brachiopods coming next. A large portion of the species were described from the Vermont beds and many have not been found elsewhere.

Most of the beds are thin, but there are some several feet thick.

The great beds of roofing slate which are extensively worked in southwestern Vermont are included in the Cambrian.

Newark Copper Deposits of Pennsylvania: Edgar T. Wherry, University of Pennsylvania.

The Newark series in eastern Pennsylvania is divisible into five formations, and attains a total

thickness of over 20,000 feet. In the upper part there is a large trap sheet, about 1,500 feet thick, which shows the character of an intrusive sill.

Copper was first mined in this region at Bowman Hill, on the Delaware, by the Dutch, from New Amsterdam, about 1650. But the most important early operation was the Old Perkiomen Mine, at Schwenksville, opened about 1700.

Three types of deposit are known: those connected with trap sills, those in fissure veins and those in unaltered shales. Deposits of the first type show grains and streaks of bornite and chalcopyrite scattered through the metamorphosed shales. In the second brecciated fissures are filled with these ores and various accessory minerals. The magmatic origin of the metals in these cases is clear enough, but the source of the films of malachite and chrysocalla occasionally found in the undisturbed and unaltered sedimentary rocks is obscure. Though perhaps none of these deposits is sufficiently rich to repay working, they are not without their interesting features.

Petrography of the Newark Intrusive Diabase of New Jersey: J. Volney Lewis, Rutgers College.

The intrusive trap that forms the Palisades of the Hudson extends in outcrops several hundred feet thick from west of Haverstraw, N. Y., southward to Staten Island and, somewhat intermittently, westward across New Jersey to the Delaware River, having an aggregate length of outcrop of about 100 miles.[1] It is everywhere a medium to fine-grained dark gray heavy rock, with dense aphanitic facies.

The typical coarser rock contains in the order of abundance, augite, plagioclase feldspars, quartz, orthoclase, magnetite and apatite. The first two occur in ophitic to equant granular textures and the next two in graphic intergrowths which sometimes constitute as much as one third of the rock. In the contact facies micropegmatite disappears and scattering crystals of olivine occur.

A highly olivinic ledge 10 to 20 feet thick and about 50 feet from the base of the sill is exposed in the outcrops northward from Jersey City for about 20 miles. The olivine crystals, which constitute 15 to 20 per cent. of the rock, occur as poikilitic inclusions in the augite and feldspar.

Chemically the trap ranges from less than 50 per cent. to more than 60 per cent. of silica, with a corresponding variation in alumina, ferric oxide and the alkalis, while ferrous iron, lime and magnesia vary inversely. The augite is rich in these latter constituents and poor in alumina, giving a great preponderance of the hypersthene and diopside molecules. The feldspars range from orthoclase and albite to basic labradorite. Doubtless there is always more or less anorthoclase also, since all feldspar analyses show potash.

While there is considerable range in the proportions of the minerals, augite usually comprises about 50 per cent. of the rock, the feldspars about 40 per cent., quartz 5 per cent. and the ores 5 per cent., constituting a quartz-diabase, with normal diabase and olivine-diabase facies. In the quantitative system it is chiefly a camptonose (III., 5, 3, 4), with the acidic *dacose* (II., 4, 2, 4) and *tonalose* (II., 4, 3, 4) and the more basic *auvergnose* (III., 5, 4, 4, 5) facies. The olivinic ledge is *Palisadose* (IV., 1^2, 1^2, 2), the name here suggested for this hitherto unnamed subrang.

Slight basic concentration at the contacts, possibly according to Soret's principle, followed by differentiation by gravity during crystallization of the main mass, especially by the settling of olivine and the ores and the rising of the lighter feldspars in the earlier and more liquid stages of the magma, accounts for the facies observed and their present relations.

The Origin of Beach Cusps: D. W. Johnson, Harvard University.

Two theories have been advanced to account for the origin of beach cusps. According to one theory the cusps result from the accumulation of seaweed along the shore and the breaking of water through the seaweed barrier, removing sand and gravel where the break occurs and molding the remaining deposits into cuspate forms. According to the second theory the cusps are formed where intersecting waves reach the shore. There are serious theoretical objections to both these theories and still more serious practical objections. Experiments show that the cusps can be formed in the laboratory by parallel waves which are in turn parallel to the beach; and numerous observations seem to show that they are generally so formed in nature. The cause of cusp formation is to be found in the physical properties of fluids descending an inclined plane, as will be shown more fully in a forthcoming paper.

The Form of Nantasket Beach: Wm. G. Reed, Jr., Harvard University.

Nantasket Beach consists of several drumlins

[1] J. Volney Lewis, "Structure and Correlation of the Newark Trap Rocks of New Jersey," *Bull. Geol. Soc. of America*, Vol. 18, 66, 195–210; also "Origin and Relations of the Newark Rocks," Ann. Rept. State Geologist of New Jersey, for 1906, pp. 97–129.

tied together and to the mainland by a complex system of tombolos. Some of the drumlins show sea cliffs now abandoned by the waves. From the relations of these cliffs and the more ancient of the beaches, the initial drumlins have been reconstructed. The effect of marine action in cliffing the drumlins and stringing out the eroded material in successive tombolos has been followed through step by step, until the conditions of to-day were reached.

The study shows that Nantasket Beach is not the result of the accidental tying together of a few islands without system, but that it represents one stage in a long series of evolutionary changes, which have occurred in orderly sequence and in accordance with definite physiographic laws.

The Acid Extreme of the Cortlandt Series near Peekskill, N. Y.: CHARLES P. BERKEY, Columbia University.

The rocks of the Cortlandt series are known, through the work of the late Professors J. D. Dana and H. S. Williams. They occupy an area on the Hudson River just south of Peekskill, N. Y., and include a very wide range of granitoid medium to basic types of igneous rocks.

It seems certain that they represent a case of magmatic differentiation that includes not only the Cortlandt series, as outlined by Dana and Williams, but also two or three occurrences of typical granite. The granite area borders basic varieties on the northeast side. Actual contacts of the larger masses are not to be seen, but an occasional dike of granite cuts the adjacent diorite and gabbros, indicating a relationship as one of the latest developments. Furthermore, the granite shows consanguinity by its heavy soda content, soda-lime, feldspar predominating. It is, however, a very acid granite and introduces a considerably greater range of rock variety than formerly credited to the Cortlandt series, becoming its acid extreme.

The Evolution of Bogoslof Volcano in Bering Sea: T. A. JAGGAR, JR., Massachusetts Institute of Technology.

The island consists of four prominent peaks, old Bogoslof at the south, McCulloch Peak steaming actively in the middle, Metcalf Cone (sometimes called Perry Peak) adjacent to McCulloch in the north, and New Bogoslof or Fire Island ("Grewingk"), a flat table rock at the northwest end of the group. These are now all connected by continuous gravel and sand strips, where in one place there was a broad channel and seven fathoms of water a year ago.

McCulloch Peak and Metcalf Cone are both products of the slow pushing up from beneath the waves of a mass of refractory lava, semi-solid, crusting and breaking into blocks as it rises, with only the central portions retaining a semblance of fluidity.

A series of sketches were shown illustrating the remarkable differences in outline of this island at different intervals from 1826 to 1907.

In 1796 Old Bogoslof rose. In 1884 New Bogoslof, Fire Island, came into being and the waves joined the two with bars. In 1891 New Bogoslof was still steaming. In 1906 Metcalf Cone was reported midway between Old and New Bogoslof. In July, 1907, Metcalf Cone had broken in two, and the breaches between the islands were again connected with continuous land. On September 1, 1907, McCulloch Peak exploded and was wholly destroyed.

No such extraordinary story of growth and alteration of an island in the sea has ever been told before, and the changes of the later stages are unique in the annals of volcanology.

This paper is printed in full in the report of the expedition to Bogoslof.

Some Curves illustrating Coincident Volcanic, Seismic and Solar Phenomena: ELLSWORTH HUNTINGTON, Yale University.

In discussions of the possibility of some relationship between sunspots and earthquakes or volcanoes, attention has usually been concentrated upon sunspot maxima. Jenson, an Australian, however, has plotted the most important earthquakes and volcanic eruptions for the last century and more, and on comparing his data with the sunspot curve for the same period finds that there seems to be a grouping of the terrestrial phenomena at or near the time of sunspot minima. In order to test the validity of his conclusions another set of data as to earthquakes and volcanoes, prepared by Mr. R. W. Sayles for quite a different purpose, have been taken and similarly compared with the sunspot curve. In this case, as in the other, the grouping of terrestrial phenomena at times of sunspot minima is evident. In order to get rid of the personal equation, which enters so largely into such studies, and in order to get rid of temporary or local irregularities, all the data of both Sayles and Jensen have been averaged together. By repeated averaging of results as to the frequency and intensity of both earthquakes and volcanoes, the whole body of facts given by the two investigators, for a period of 117 years in one case, and 147 in the other, has

been combined into a single curve representing the progress of volcanic and seismic phenomena during the average sunspot cycle for the same period. On comparing this curve with the average sunspot curve, it appears that the minimum of the one coincides exactly with the maxima of the other and *vice versa*, and that times of increase in the one set of phenomena are times of decrease in the other. The coincidence can not possibly be accidental, for the repeated process of averaging would prevent the two curves from agreeing unless there were a genuine cause of agreement. The remarkable nature of the coincidence suggests that there is some common cause at work, producing a maximum occurrence of earthquakes and volcanoes upon the earth and a minimum occurrence of spots on the sun. The data used do not claim to be exhaustive, and the results are advanced as suggestive, rather than conclusive.

This paper appeared in full in the *Popular Science Monthly* for June.

The Volcanoes and Rocks of Pantelleria: HENRY S. WASHINGTON, New York.

Pantelleria is entirely volcanic. Its geologic structure has been variously interpreted, and the views of the writer differ in some important respects from those of other observers, notably Foerstner and Bergeat. There is supposed to have been formed first a large volcano, covering practically the whole area and submarine in its first stages. This was composed of rather siliceous soda-trachytes and later green pantellerites. The central and upper parts of this cone disappeared, probably by explosion, in analogy with the history of many other volcanoes, leaving a large central caldera, surrounded by an encircling somma with steep inner scarps and gentle outer slopes. Within the caldera arose the cone of the second period, now represented by Montagna Grande, the summit of which is the culminating point of the island, and Monte Gibele on the southeast. The lava of these is a very uniform soda-trachyte. The crater of Monte Gibele seems to have been the original eruptive center for the joint mass, but later the block of Montagna Grande was separated from the Gibele cone by a fault, with considerable tilting of the fault block. On the western and northern sides of this block there were formed several small parasitic cones, which gave vent to flows of black, glassy pantellerite. These and the trachytic flows of the Gibele volcano nearly filled the whole floor of the original caldera, the only portion left uncovered being a small corner at the north, where there is a small elliptical lake, which is thus regarded as a residual of the old caldera floor and not an eruptive center. The next phase of eruptive activity was confined to the northwestern part of the island, and the lavas are entirely feldspar-basalts, forming several small cinder cones, with flows of scoriaceous basalt. Eruptive activity on the island proper seems to have ceased, and is now evident only in some fumeroles and hot springs. The rocks show a wide range in chemical composition, but belong to but few distinct types. They are characterized by high soda, giving rise to the presence of abundant soda-microcline, ægirite and the triclinic cossyrite among the more salic types, and by the high amount of titanium among the basalts.

Other papers presented and those read by title are as follows:

Geology of Long Island: W. O. CROSBY, Massachusetts Institute of Technology.

Salt Formations of Louisiana: G. D. HARRIS, Cornell University.

Certain Silicified Tertiary Rocks of Arkansas: R. ELLSWORTH CALL, New York City.

Recent Advances in our Knowledge of the Magnetite Bodies at Mineville: JAMES F. KEMP, (By permission of the State Geologist of New York.)

Interpretation of the Mineral Constitution of Magnesian Minerals through their Analyses: ALEXIS A. JULIEN, Columbia University.

Silicified Woods of the Arkansas Tertiary: R. ELLSWORTH CALL, New York City.

Dwarf Faunas: HERVEY W. SHIMER, Massachusetts Institute of Technology.

Structure of the Brachial Support of Camarophorella, a Mississippian Meristelloid Brachiopod: J. E. HYDE, Columbia University.

A Revised Classification for the North American Lower Paleozoic: A. W. GRABAU, Columbia University.

Marginal Glacial Deposits: R. S. TARR, Cornell University.

An Erosion Problem in Arid Regions: RICHARD E. DODGE, Teachers College.

Notes on Recent Mineral Occurrences: GEORGE F. KUNZ, New York City.

The Gibeon Meteorite and other Recent Accessions at the American Museum: EDMUND OTIS HOVEY, American Museum of Natural History.

CHARLES P. BERKEY,
Secretary of Section